49.001

AC-DC CONVERTER
49.001

EAI

ELECTRONIC ASSOCIATES INC. ■ LONG BRANCH, NEW JERSEY

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AC-DC CONVERTER
49.001

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1. GENERAL DESCRIPTION OF AC-DC CONVERTER 49.001 (See Figure 1.)

The EAI (Electronic Associates, Inc.) AC-DC Converter 49.001 is a self-contained, solid-state, precision instrument designed for the conversion of sinusoidal a-c signals to equivalent d-c potentials. The converter is calibrated to produce a d-c output proportional to the RMS value of the true sine-wave input.

The AC-DC Converter, in conjunction with a high-accuracy d-c voltmeter (such as the EAI 5000 Series TDVM), provides a highly reliable and accurate a-c measurement system for laboratory or field use. In addition, the fast settling time makes the 49.001 a suitable instrument for automatic logging systems.

Complete solid-state component design makes this instrument a compact, light weight, easily transportable unit. The converter contains an amplifier-diode rectification circuit that is independent of the diode characteristics. Second-order electronic filters and precision components assure an accurate, ripple-free, d-c output. Ease of amplifier balance (with self-contained circuitry) and simple d-c calibration procedures assure instrument accuracy even for extended field use.

The converter has four operational ranges: 0 to 1 volt, 0 to 10 volts, 0 to 100 volts, and 0 to 1000 volts. In addition, the unit has a direct feed-through circuit that enables the operator to by-pass the converter circuitry and connect the input device directly to the readout device without necessitating cable connection changes. Selection of the four ranges and the by-pass (or direct) circuit is controlled from a front panel RANGE control switch.

Figure 1. AC-DC Converter 49.001

2. TECHNICAL AND PHYSICAL DATA

a. Physical

Height..... 6-1/4 inches

Width..... 10 inches

Depth..... 18-1/2 inches

Weight..... 15 pounds

b. Technical

Input Ranges and Impedance*

Range	Impedance
0 to 1 volt (RMS)	2500 ohms
0 to 10 volts (RMS)	25,000 ohms
0 to 100 volts (RMS)	250,000 ohms
0 to 1000 volts (RMS)	2.5 megohms

Output

0 to +10 volts d-c on all ranges*

Output Current

10 milliamperes (resistive load of 1000 ohms or greater)

Output Impedance

0.2 ohms at 10 milliamperes

Accuracy

D.C. - Within ±0.01% of Full Scale				
A.C.	1 Volt	10 Volt	100 Volt	1000 Volt
±0.05% FS	1KC	1KC	1KC	1KC
±0.1% FS	5KC	5KC	5KC	3KC

Settling Time

120 milliseconds

Noise

Total and ripple less than 2 millivolts peak-to-peak

*NOTE: The 49.001 is designed to handle 20% input overloads thus facilitating the use of this instrument with expanded range units such as the EAI 5001 TDVM.

Resolution

Essentially Infinite - limited only by presence of random noise and ripple in the input.

Power Requirements

105/125 volts a-c, 50/60 cycles per second

Power Consumption

12 watts

Rated Operating Temperature

55°F to 100°F

Input and Output Connections

Single-ended

3. INSTALLATION AND PRELIMINARY ADJUSTMENTS

The AC-DC Converter is a completely self-contained instrument and comes complete with input, output, and power cables. There are no special installation procedures nor are any preliminary adjustments required.

The input and output connectors are readily accessible at the front panel. If it is desired to permanently mount and wire-in the unit, coaxial input and output terminations are available on the rear of the chassis (P1-A1 and P1-A2 respectively). The protective dust cover must be removed for access to these terminations.

4. OPERATION

All of the operating controls of the converter are located on the front panel (including the 1/4 ampere line fuse). The instrument is extremely simple to operate once the function of the various controls is understood.

a. Converter Control Functions

Table 1 lists the various controls, switches, and indicators of the converter and gives a brief description of the function of each.

b. Amplifier-Balance Check Procedure

The four amplifiers of the 49.001 should be checked each time the unit is turned on and at least daily when in continuous operation. In most cases it will be found that amplifier balancing is not necessary; however, the check assures continued readout accuracy. The built-in balance-check circuitry provides a convenient and rapid check-out operation.

(1) Place the BALANCE switch in the position 1. — ou 47.035 —

NOTE: *Allow a minimum of 10 minutes warm-up time. If the unit has been in operation, proceed immediately to step (2).*

(2) Ground the converter input termination.

(3) The front panel milliammeter should read zero. If necessary, loosen the lock-nut on the BALANCE ADJUST-1 screwdriver control and adjust for a zero meter reading. Tighten the lock-nut taking care not to disturb the control setting.

(4) Place the BALANCE switch, in sequence, in positions 2, 3, and 4. Adjust the corresponding BALANCE ADJUST controls for a zero meter reading if necessary.

NOTE: *Always adjust the amplifier BALANCE ADJUSTMENTS in ascending numerical order.*

TABLE 1. Converter Control Functions

Control	Function
RANGE Switch	Five-position switch for selection of desired operating range of the converter. The DIR position connects the input connector directly to the output connector.
BALANCE Switch	Controls the operational status of the converter. For normal operation of the converter this switch is placed in the OP position. Positions 1, 2, 3, and 4 permit balancing the four amplifiers in conjunction with the microammeter. In addition this switch controls the application of primary power to the unit.
Microammeter	Center-zero meter used in conjunction with the BALANCE switch for convenient and rapid amplifier balance adjustments.
BALANCE ADJUST Controls	Each control is the balance adjustment of one of the four amplifiers. The amplifiers should be balanced in order as indicated by the numeric designation of the adjustments.
POWER Indicator	Indicates application of primary power.
1/4 Ampere Fuse	Protects power source and converter circuitry in event of short-circuit or overload.
INPUT Connector	Shielded connector for the application of input a-c signals.
OUTPUT Connector	Shielded connector for converter d-c output.

c. Normal Converter Operation

(1) Connect the INPUT and OUTPUT terminations to the external equipment.

(2) Select the proper RANGE switch setting.

NOTE: *Always start on the 1000 volt range for unknown inputs.*

(3) Place the BALANCE switch in the OP position. Decrease the RANGE switch setting to the lowest possible range which maintains the output in the 0 to +10 volt region (25% input over-voltage allowable).

CAUTION: *Overloads beyond the allowable 20% over-range of the converter may damage the input precision resistors.*

The DIR position of the RANGE switch connects the input jack directly to the output jack. The output readout-device sensitivity and frequency response must be considered prior to switching to the DIR position.

5. THEORY OF OPERATION

The AC-DC Converter, Model 49.001 converts a-c input signals ranging from 0 to 1000 volts to d-c equivalent voltages. The output is a scaled, positive d-c potential equivalent that is proportional to the RMS value of the input signal. The d-c output is in a range of 0 to +10 volts and is in direct proportion to the selected conversion range; i.e., 100 volts RMS input on the 100 volt range produces a +10 volt d-c output; however, on the 1000 volt range the 100 volt potential is read out as +1 volt d-c.

a. Functional Diagram Analysis

Figure 2 is a functional diagram illustrating the operation of the Model 49.001 Converter. (For a more detailed circuit layout, see Simplified Schematic D049 001 0S.) The following description assumes that the converter is set on the 1 volt range and that an a-c signal of 1 volt RMS is applied to the unit input.

The a-c signal is applied to both amplifier 1A and 1B through precision input resistors. Amplifier 1B in the 1-volt range has a gain of approximately five. Diodes CR1 and CR2, however, clamp the amplifier 1B output at zero during the negative half-cycle of the input; thus, the output of amplifier 1B is a negative half-wave signal with a peak voltage of 7.07 volts (five times the peak voltage of the a-c input).

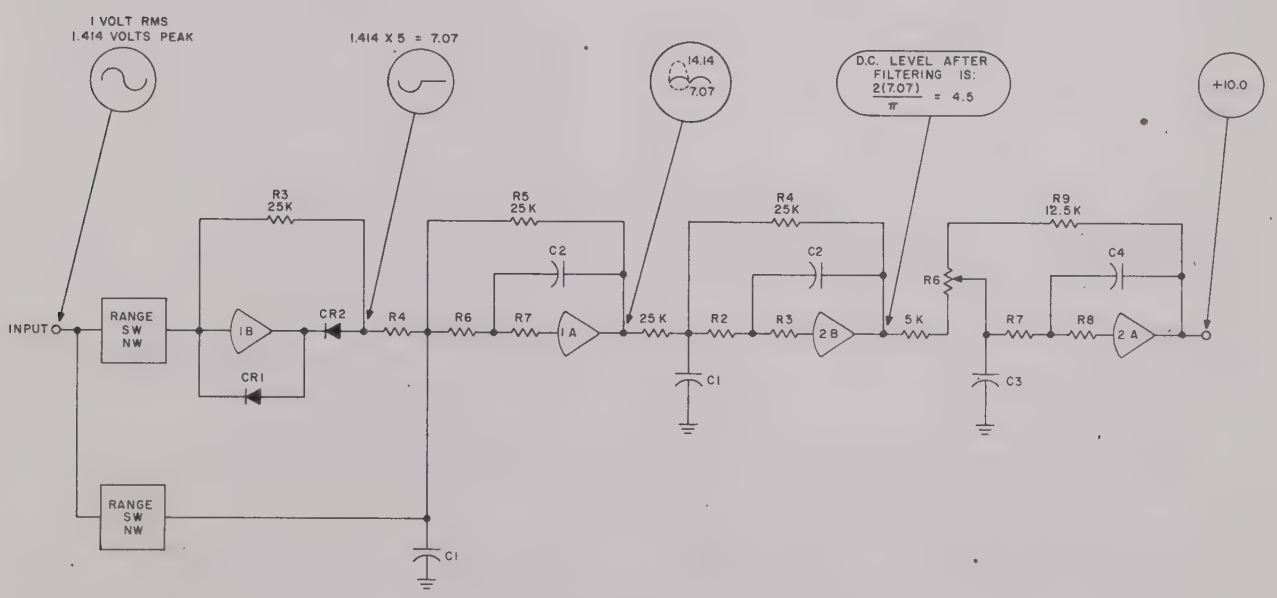


Figure 2. AC-DC Converter 49.001, Function Diagram

The output of the amplifier 1B is summed with the input signal by amplifier 1A. Figure 3 is a simplified schematic of the amplifier 1A circuit. The half-wave output signal of amplifier 1B is amplified at a factor of two by amplifier 1A while the a-c input signal is amplified approximately five times. The half-wave signal of 14.14 volts peak, and the a-c signal of 7.07 volts peak, are algebraically summed by amplifier 1A. Due to the inherent inversion of amplifier 1B the half-wave signal is 180° out of phase with the a-c input. Thus, as shown in Figure 2, the result of summing the half-wave 14.14 volt signal with the 7.07 volt out-of-phase, half cycle of the a-c input, is a positive peak 7.07 volt signal. The remaining half cycle of the a-c input, already 7.07 volts, and occurring when the output of 1B is clamped at zero, produces a signal at the output of amplifier 1A which is essentially the result of full-wave rectification. With this circuit arrangement slight changes in diode characteristics are negligible; and with relatively simple d-c gain adjustments, the diode-characteristic change effect may be eliminated entirely.

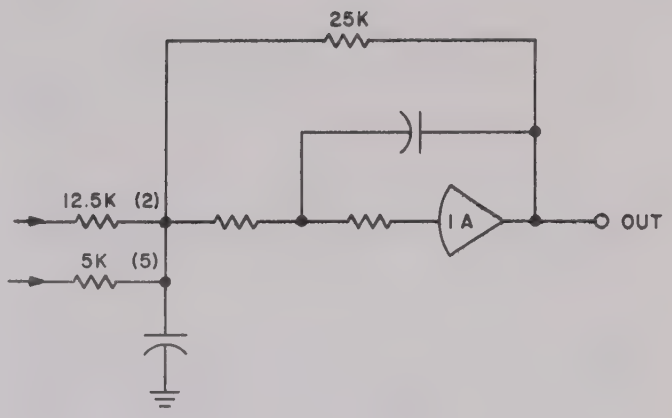


Figure 3. Amplifier 1A, Simplified Schematic

Capacitors C1, C2 and resistors R4 through R6 plus R16 and R17 (for the 1 volt range) in conjunction with amplifier 1A, comprise a second order active filter. (See Drawing D049 001 0S and Figure 2.) Amplifiers 2A and 2B, with their associated circuitry, form similar second-order active filters. The output of the converter is a highly-filtered, ripple-free, d-c potential. The gain of the final amplifier (2A) is set to produce a d-c output in scaled proportion to the RMS value of the a-c input; in this example the output is +10 volts d-c.

b. Component Circuit Descriptions

(1) *Dual D. C. Amplifier 6.334-2.* (See Drawing D006 334 0S.) This printed-circuit card contains two identical, independent, chopper-stabilized amplifier circuits. This description is, therefore, limited to the amplifier channel shown on the upper half of the Schematic (D006 334 0S). This channel is amplifier 1A of Dual D.C. Amplifier-1 or amplifier 2A of Dual D. C. Amplifier 2. (See Drawing D049 001 0S.)

The amplifier channel consists of a six transistor, d-c amplifier section and a three transistor, a-c stabilizing section. D-C input signals applied to INPUT A are blocked from the base of Q17 by C1 but are applied to the chopper through R14. Chopper D1 applies a 60 cycle square wave through C7 to the base of Q6. The signal, after amplification by Q7 through Q8, is applied as d-c to the base of Q17. Restoration of the square wave to d-c is accomplished by chopper contacts 1 and 2, and C2.

Transistors Q17 and Q1 comprise the d-c section input stage. Q1 is a common-emitter configuration and Q17 a common-collector configuration. Q17 uses the voltage drop across the base-emitter diode of Q1 as its operating voltage. Q17 also uses the base-emitter resistance of Q1 as its load; this configuration causes the input impedance to be relatively high (approximately 10K).

The output of Q1 is direct-coupled to the base of Q2 which is connected in a common-base configuration. High-frequency compensation is provided for Q2 by C4 and R4. Capacitors C3 and C5 provide phase correction of high input frequencies.

Q2 is direct-coupled to Q3; the circuit configuration of Q3 is similar to Q2 except that the emitter of Q3 is returned to +15 volts. This arrangement provides the required operating point for Q3, Q4, and Q5. Q3 functions as a driver for the Q4 and Q5 output stage.

Transistor Q4 is a PNP and Q5 an NPN-type transistor; both are connected in the common-collector (or emitter-follower) configuration. The circuit employs the advantages of the complementary symmetry of the two types of transistors to provide push-pull operation with a single-ended input.

With no signal applied, the forward bias developed across R9 causes a small current to flow from the -15 volt supply through Q4, I1, I2, and Q5 to the +15 volt supply. Because of the similarity of characteristics, the voltage drop across Q4 and I1 equals that of I2 and Q5; like a balanced bridge circuit there is no current flow through the external load. If, however, an input signal causes one amplifier to conduct more heavily, an unbalance of

the bridge develops, and current flows through the load. The output appears between pin Z (output A) and pin Y (± ground) of the printed-circuit card.

The incandescant lamps (I1 and I2) increase in resistance as the current flow through them increases. The lamps serve to stabilize the output and protect the transistors by limiting the output current flow.

Diodes CR1 and CR2 at the input of the amplifier channel limit the charge on capacitor C1 during momentary overloads. This allows the amplifier to quickly recover should an overload occur.

(2) *Power Supply Regulator 43.031-2.* (See Drawing C043 031 0S, Sheet 2.) The Power Supply Regulator Card contains three separate regulators to supply the ±15 volts d-c and +30 volts d-c required by the converter. The operation (and circuit configurations) of the three regulators are essentially identical; therefore, only the -15 volt regulator is described in detail.

The primary a-c input is stepped down across transformer T1 and applied to the full-wave rectifiers CR8 and CR9 of the -15 volt regulator. Capacitor C11 filters the rectified d-c and R31 is a current limiting resistor. Transistor Q10 is the circuit series regulator and acts as a variable resistance, increasing or decreasing the output current to maintain a constant -15 volt output at pin S.

To visualize the circuit operation, assume the -15 volt potential (at pin S) tends to increase (go more negative). The increase is applied to the wiper of R25 in the voltage divider consisting of R24, R25, and R26. This increased negative potential causes Q12 to conduct more heavily and drive the base of Q11 positive. The decrease in conduction of Q11 decreases the negative potential on the base of the series regulator (Q10). This increases the impedance of transistor Q10 and prevents the potential at pin S from increasing. A tendancy for a decrease in potential at S would in a similar manner, decrease the impedance of the series regulator.

Diode CR10 maintains the emitter of Q12 at a constant potential; the emitter voltage acts as the reference point of the regulator circuit. C10 prevents the circuit from reacting to transient pulses.

The +15 volt regulator is identical to the -15 volt regulator except the output is taken from the opposite lead. The +30 volt regulator is also similar except that the +15 volt output is used as reference for the regulator in order to develop the +30 volt potential.

(3) *Meter and Protection Network 49.030.* (See Drawing D049 001 0S.) The meter circuit protects the center-zero milliammeter from current overloads, but also permits the meter to present maximum sensitivity for the amplifier-balance adjustments. The network is designed to cause the deflection-versus-current curve of the meter to be exponential in nature. In this manner, an increase in current does not cause linear deflection and pin the indicator needle, but as current decreases, the meter sensitivity increases.

6. CALIBRATION

The AC-DC Converter 49.001 is factory calibrated at the time of manufacture and under normal operating conditions should remain within the required tolerance limits. Rough handling or replacement of precision components may necessitate re-calibration. The calibration procedures in this section are divided into two groups: d-c calibration and a-c calibration procedures.

The d-c calibration procedure presents a comparatively simple but accurate method of assuring the instrument accuracy even in extended field use. D-C calibration should only be made when a d-c gain check (as outlined in paragraph 7) definitely indicates adjustment error.

The a-c calibration should only be made if precision components effecting these adjustments are replaced. Prior to starting the a-c calibration procedures the instrument *must be d-c calibrated.*

a. D-C Calibration

Two equally accurate methods of d-c calibration are given in this section. The choice of which method to use is dependent on the availability of the required test equipment. The first method requires an L & N 100K Null Voltage Test Set and galvanometer (or equivalent) and the second method requires a d-c voltage source accurate to 0.005%.

Because the 49.001 is calibrated to provide the scaled d-c equivalent of the a-c input RMS value, d-c inputs produce an output multiplied by the factor $2\sqrt{2}/\pi$; or $E_{in} = 0.90032\ E_{out}$.

NOTE: *Prior to attempting an alignment procedure allow at least 10 minutes warm-up time and check the amplifier balance.*

First Method:

(1) *Negative D-C Input Calibration.* In the following procedural steps a parenthetical notation is given after each component card-reference, indicating the chassis-plug number into which the card is inserted.

(a) Set potentiometer R6 on Amplifier Network 12.209 (J3) and potentiometer R7 on Amplifier Network 12.207 (J2) to the center of their travel.

CAUTION: *During the calibration procedure, double-check all potentiometer locations and designations to be certain that the correct component is being set.*

(b) Set potentiometer R17 on Resistor Network 12.233 (J1) for 5 ohms resistance between the center-tap and pin X of J1.

(c) Set up the test circuit shown in Figure 4.

(d) Set the L & N Test Set and input potential (E_{in}) as indicated in Table 2 for each step: adjust the potentiometer listed for a null on the galvanometer.

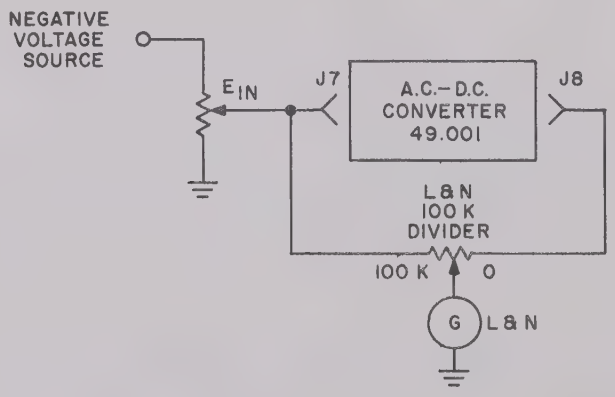


Figure 4. Negative DC Input Calibration Test Set-Up

TABLE 2. NEGATIVE D.C. INPUT CALIBRATION TEST DATA, FIRST METHOD.

STEP*	RANGE	L&N DIVIDER SETTING	E_{IN} (IN VOLTS)	ADJUST POTENTIOMETER
1	1 VOLT	91741	≦0.80	R6 ON AMPLIFIER NETWORK 12.209 (J3)
2	10 VOLT	52623	≦8.00	R19 ON RESISTOR NETWORK 12.223 (J1)
3	100 VOLT	09997	≦80.00	R21 ON RESISTOR NETWORK 12.223 (J1)
4	1000 VOLT	010985	≦100.00	R24 ON RESISTOR NETWORK 12.223 (J1)

*NOTE: THESE AND ALL SUCCEEDING ADJUSTMENTS MUST BE MADE IN THE ORDER INDICATED.

(2) *Positive D-C Input Calibration (1 and 10 Volt Ranges).*

(a) Set up the test circuit as shown in Figure 5.

(b) Set the L & N Test Set and input potential (E_{in}) as indicated in Table 3 for each step: adjust the potentiometer listed for a null on the galvanometer.

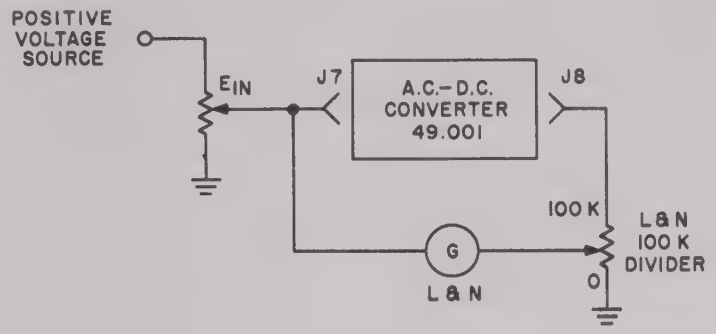


Figure 5. Positive DC Input Calibration Test Set-Up (1 and 10 Volt Range)

TABLE 3. POSITIVE D.C. INPUT CALIBRATION TEST DATA (1 AND 10 VOLT RANGE), FIRST METHOD

STEP	RANGE	L&N DIVIDER SETTING	E_{IN} (IN VOLTS)	ADJUST POTENTIOMETER
1	1 VOLT	0900317	≦0.80	R14 ON RESISTOR NETWORK 12.223 (J1)
2	10 VOLT	9003170	≦8.00	R10 ON RESISTOR NETWORK 12.223 (J1)

(3) *Positive D-C Input Calibration (100 and 1000 Volt Ranges).*

(a) Set up the test circuit as shown in Figure 6.

(b) Set the L & N Test Set and input potential (E_{in}) as indicated in Table 4 for each step: adjust the potentiometer listed for a null on the galvanometer.

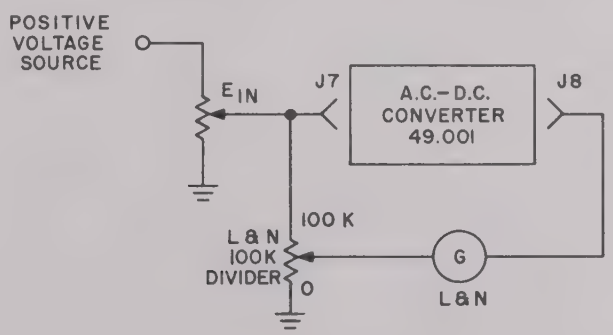


Figure 6. Positive DC Input Calibration Test Set-Up (100 and 1000 Volt Range)

TABLE 4. POSITIVE D.C. INPUT CALIBRATION TEST DATA (100 AND 1000 VOLT RANGE), FIRST METHOD.

STEP	RANGE	L&N DIVIDER SETTING	E_{IN} (IN VOLTS)	ADJUST POTENTIOMETER
1	100 VOLT	1110720	≦80.0	R6 ON RESISTOR NETWORK 12.223 (J1)
2	1000 VOLT	0111072	≦100.0	R3 ON RESISTOR NETWORK 12.223 (J1)

Second Method:

(1) *Negative D-C Input Calibration.*

(a) Set potentiometer R6 on Amplifier Network 12.209 (J3) and potentiometer R7 on Amplifier Network 12.207 (J2) to the center of their travel.

(b) Set potentiometer R17 on Resistor Network 12.223 (J1) for 5 ohms resistance between the counter-tap and pin X of J1.

(c) Set up the test circuit as shown in Figure 7.

(d) Apply the indicated negative d-c voltages listed in Table 5 for each step. Adjust the listed potentiometer to acquire the indicated TDVM readout.

(2) *Positive D-C Input Calibration.* Use the test set up as indicated in Figure 7 and repeat step (1) (d) of the second method, but use the test data in Table 6.

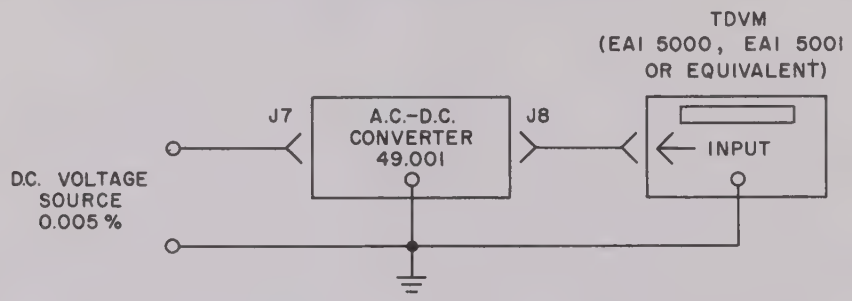


Figure 7. DC Input Calibration Test Set-Up (Second Method)

TABLE 5. NEGATIVE D.C. INPUT CALIBRATION TEST DATA, SECOND METHOD.

STEP	RANGE	E_{IN} (IN VOLTS)	TDVM READING	ADJUST POTENTIOMETER
1	1 VOLT	−0.800	+8.886 ± .0005	R6 ON AMPLIFIER NETWORK 12.209 (J3)
2	10 VOLT	−8.000	+8.886 ± .0005	R19 ON RESISTOR NETWORK 12.223 (J1)
3	100 VOLT	−80.00	+8.886 ± .0005	R21 ON RESISTOR NETWORK 12.223 (J1)
4	1000 VOLT	−100.0	+1.110 ± .0005	R24 ON RESISTOR NETWORK 12.223 (J1)

TABLE 6. POSITIVE D.C. INPUT CALIBRATION TEST DATA, SECOND METHOD.

STEP	RANGE	E_{IN} (IN VOLTS)	TDVM READING	ADJUST POTENTIOMETER
1	1 VOLT	+0.800	+8.886 ± .0005	R14 ON RESISTOR NETWORK 12.223 (J1)
2	10 VOLT	+8.000	+8.886 ± .0005	R10 ON RESISTOR NETWORK 12.223 (J1)
3	100 VOLT	+80.00	+8.886 ± .0005	R6 ON RESISTOR NETWORK 12.223 (J1)
4	1000 VOLT	+100.0	+1.110 ± .0005	R3 ON RESISTOR NETWORK 12.223 (J1)

b. A-C Calibration

The a-c calibration procedure requires precision test equipment and extreme care in execution. Two methods are outlined in this paragraph: the two-thermocouple method and the comparison method. The comparison method is the simplest to perform; however, this method requires a standard 49.001 Converter calibrated by the two-thermocouple method. The accuracy attained by the comparison method is dependent on the accuracy of the data recorded for the converter that is used as a standard.

The accuracy of the a-c thermocouple with reversed primary current should be 0.005% or *better*. The audio generator should have less than 0.2% harmonic distortion (measured with a harmonic analyzer). Use an EAI 5000 Series TDVM (or equivalent, accurate to 0.01%), an L & N 100K Null Voltage Test Set and galvanometer (or equal), and a Hewlett-Packard 425A Voltmeter (or equivalent).

NOTE: *Do not attempt the a-c calibration procedures unless the unit has first been d-c calibrated.*

Two-Thermocouple Method:

Prior to starting this calibration procedure make up a test chart similar to the one shown in Figure 8.

RANGE	V_I RMS VOLTS	V_O VOLTS	T.C. ZERO CALIBRATION	FREQUENCY										
				50	130	400	800	1KC	1.6KC	2KC	2.5KC	3KC	5KC	8KC
1	0.1	1.0												
	0.5	5.0												
	0.9	9.0												
10	1.0	1.0												
	5.0	5.0												
	9.0	9.0												
100	10.0	1.0												
	50.0	5.0												
	90.0	9.0												
1000	110.0	1.1												

$$\Delta V = \frac{V_O}{2} \times \frac{E_2}{E}$$

E = 4.5 TO 5 mv. (LEVEL FIGURE)

$E_2 = \pm$ _____ MICROVOLTS (ERROR FIGURE)

Figure 8. Two Thermocouple Test Chart

(1) *1 Volt Range Calibration.* There is no a-c calibration adjustment required for the 1 volt range; however, the following check should be performed and the data recorded.

(a) Set up the test circuit shown in Figure 9. Switch S3 in this circuit is a safety feature and although not essential for the test circuit operation, it prevents possible accidental destruction of the thermocouples.

(b) Place switch S1 in position A and S2 in the LEVEL position.

(c) Set the L & N Test Set for a setting of 1000.

(d) Set R2 for maximum resistance to ground and R1 for an output of the converter (V_O) equal to 9.0 volts.

(e) Balance the galvanometer with R2.

(f) Set the 1000 ohm potentiometers of R_{DC} and R_{AC} for maximum resistance. Set the 50 ohm potentiometers at mid-range.

NOTE: *The 50 ohm potentiometers are to be used as fine adjustments during the calibration procedures.*

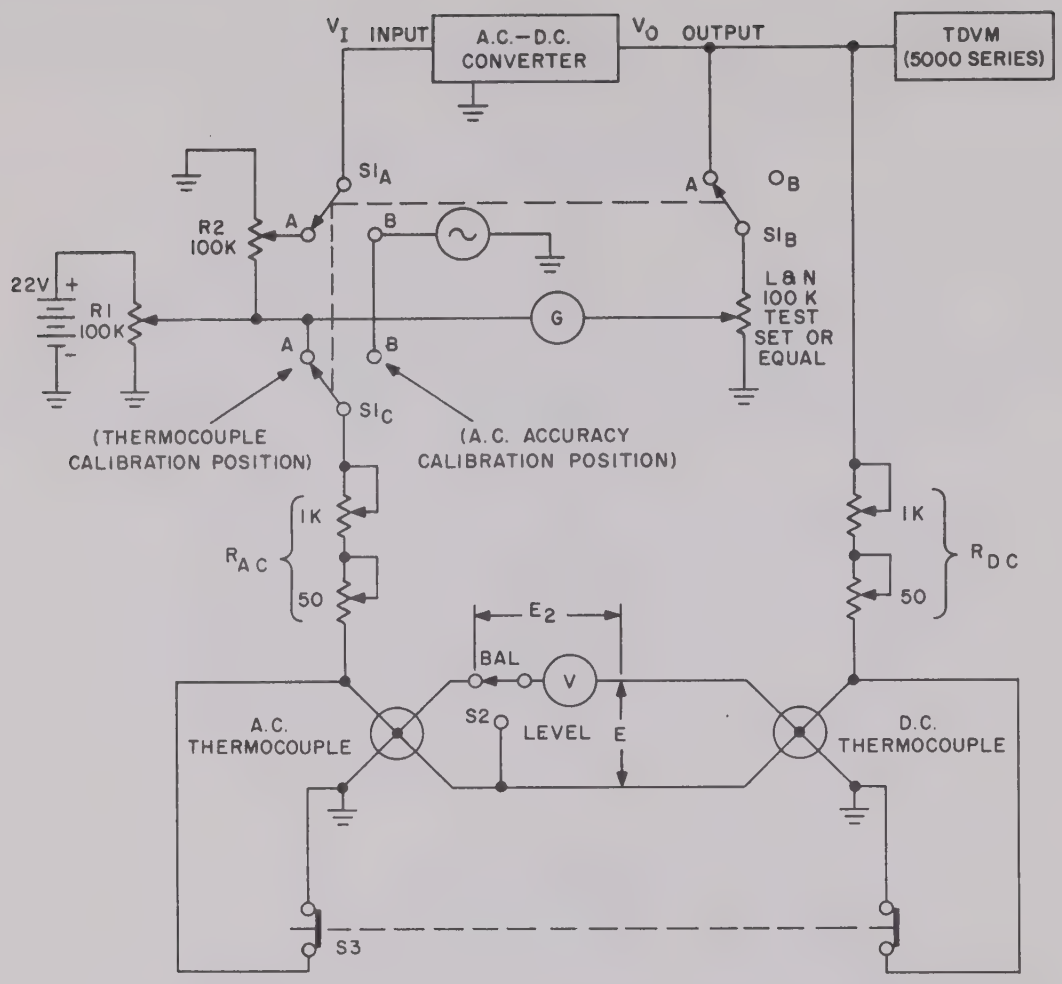


Figure 9. Two-Thermocouple Test Set-Up, 1 Volt Range

(g) Depress switch S3 and adjust R_{DC} for a reading (E) of 4.5 to 5 millivolts on the voltmeter. Record the actual reading on the test chart as the T.C. *calibration* (use the space provided in the 1 volt range, V_1 = 0.9 volt area).

(h) Set switch S2 in the BAL position. Depress S3 and adjust R_{AC} for a zero reading (E_2) on the voltmeter (with voltmeter set in the microvolt range). Holding output V_0 constant by means of R1.

(i) Place S1 in position B.

(j) Apply an a-c input of 0.9 volts RMS (TDVM reading of 9.000 ±0.005 volts) at 50 cps to the converter input.

(k) Record the percent error of full scale ($\Delta V_0\%$) versus frequency at V_1 = 0.9 volt in the area provided in the test chart. Calculate $\Delta V_0\%$ for 0.9 volts RMS as $\Delta V_0\% = E_2\ 10^4$ (where E_2 is in microvolts).

(l) Repeat steps (j) and (k) for each of the frequencies listed in the chart for V_1 = 0.9 volt.

(m) Place S2 in the LEVEL position, depress S3 and record E (in *millivolts* as the T.C. *calibration* for V_1 = 0.5 volt RMS.

(n) Record $\Delta V_0\%$ for the various frequencies listed for $V_1 = 0.5$ volt.

$$\Delta V_0\% = E_2 \left(\frac{10^4}{2} \right)$$

(o) Repeat step (m) and record as T. C. *calibration* for $V_1 = 0.1$ volt RMS.

(p) Record $\Delta V_0\%$ for the various frequencies listed for $V_1 = 0.1$ volt. ($\Delta V_0\% = E_2\ 10^3$)

(q) Repeat step (m) and record in the chart. This value (T. C. *calibration must remain constant throughout the test procedure in the 1 volt range.*

(2) *10 Volt Range Calibration.*

(a) Set up the test circuit shown in Figure 10.

(b) Place switch S1 in position A and S2 in the LEVEL position.

(c) Repeat steps (d) through (i) as outlined for the 1 volt range. (Record the T. C. *calibration* in the space provided for the 10 volt range and $V_1 = 9.0$ volts.)

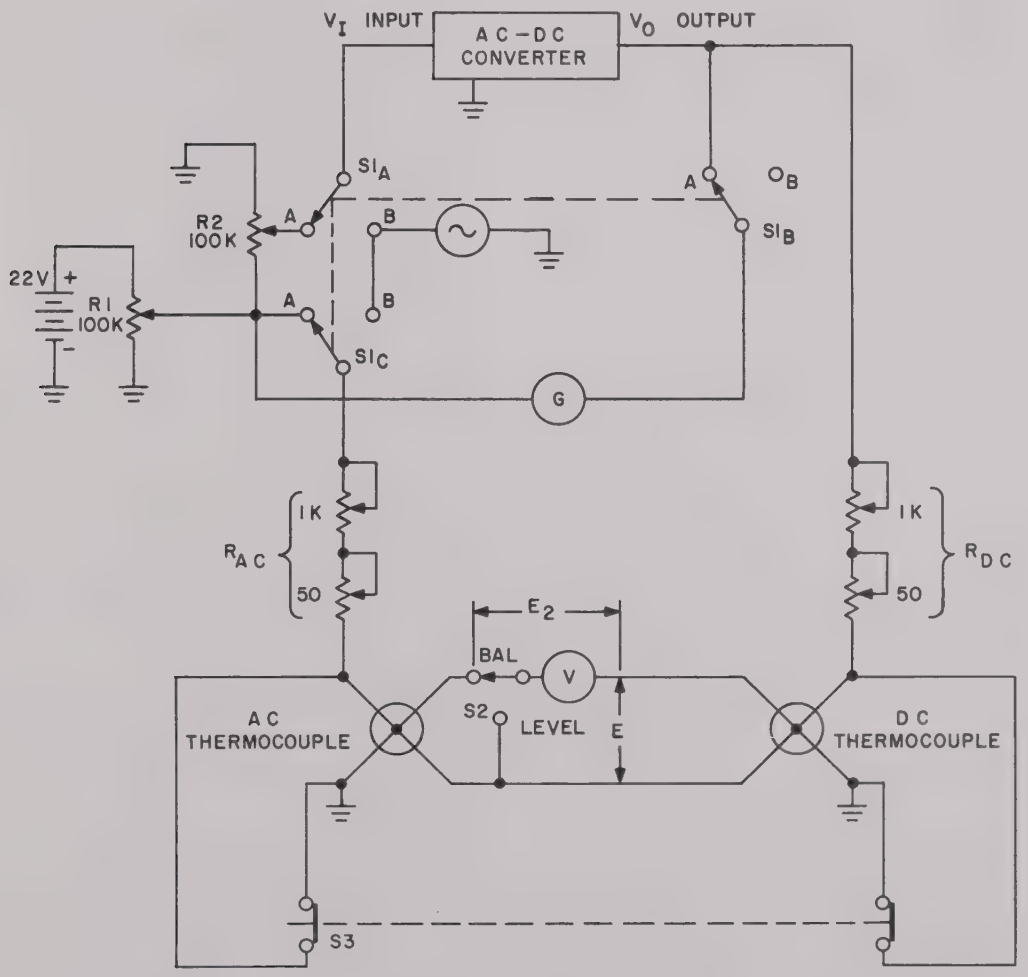


Figure 10. Two-Thermocouple Test Set-Up, 10 Volt Range

(d) Record the $\Delta V_0\%$ versus frequency in a similar manner as accomplished for the 1 volt range. Check and record the T. C. *calibration* before each group to ascertain test accuracy. The value of $\Delta V_0\%$ is calculated as follows:

$$V_1 = 9 \text{ volts RMS } \Delta V_0\% = E_2 (10^4) \quad (1)$$

$$V_1 = 5 \text{ volts RMS } \Delta V_0\% = E_2/2 (10^4) \quad (2)$$

$$V_1 = 1 \text{ volt RMS } \Delta V_0\% = E_2 (10^3) \quad (3)$$

where E_2 is in microvolts in each case.

(e) *If* the recorded values *are not* within the required tolerances apply the inputs and make the adjustments as indicated in Table 7. Upon completion of these adjustments repeat steps (b) through (d).

TABLE 7. 10 Volt Range Calibration Adjustments

V_1 (RMS VOLTS)	V_0 (VOLTS)	INPUT FREQUENCY (CPS)	ADJUSTMENT	E_2 (MICROVOLTS)
9 volts	9.000	2500	Adjust C2 on Resistor Network 12.223 (J1) for a minimum value of E_2.	
9 volts	9.000	2500	Adjust C4 on Resistor Network 12.223 (J1) for indicated value of E_2.	-2

(3) *100 Volt Range Calibration*

(a) Set up the test circuit as shown in Figure 11. (This circuit is also used for the 1000 volt range calibration.)

(b) Repeat steps (b) through (i) as outlined for the 1 Volt Range Calibration.

(c) Record $\Delta V_0\%$ versus frequency as indicated by the test chart. Check and record the T. C. Zero Balance before each group to assure test accuracy. The value of $\Delta V_0\%$ is calculated as follows:

$$V_1 = 90 \text{ volts RMS } \Delta V_0\% = E_2 (10^4) \quad (4)$$

$$V_1 = 50 \text{ volts RMS } \Delta V_0\% = E_2/2 (10^4) \quad (5)$$

$$V_1 = 10 \text{ volts RMS } \Delta V_0\% = E_2 (10^3) \quad (6)$$

where E_2 is in microvolts in each case.

(d) *If* the recorded values *are not* within tolerance make the adjustments indicated in Table 8. Upon completion of adjustments repeat steps (b) and (c).

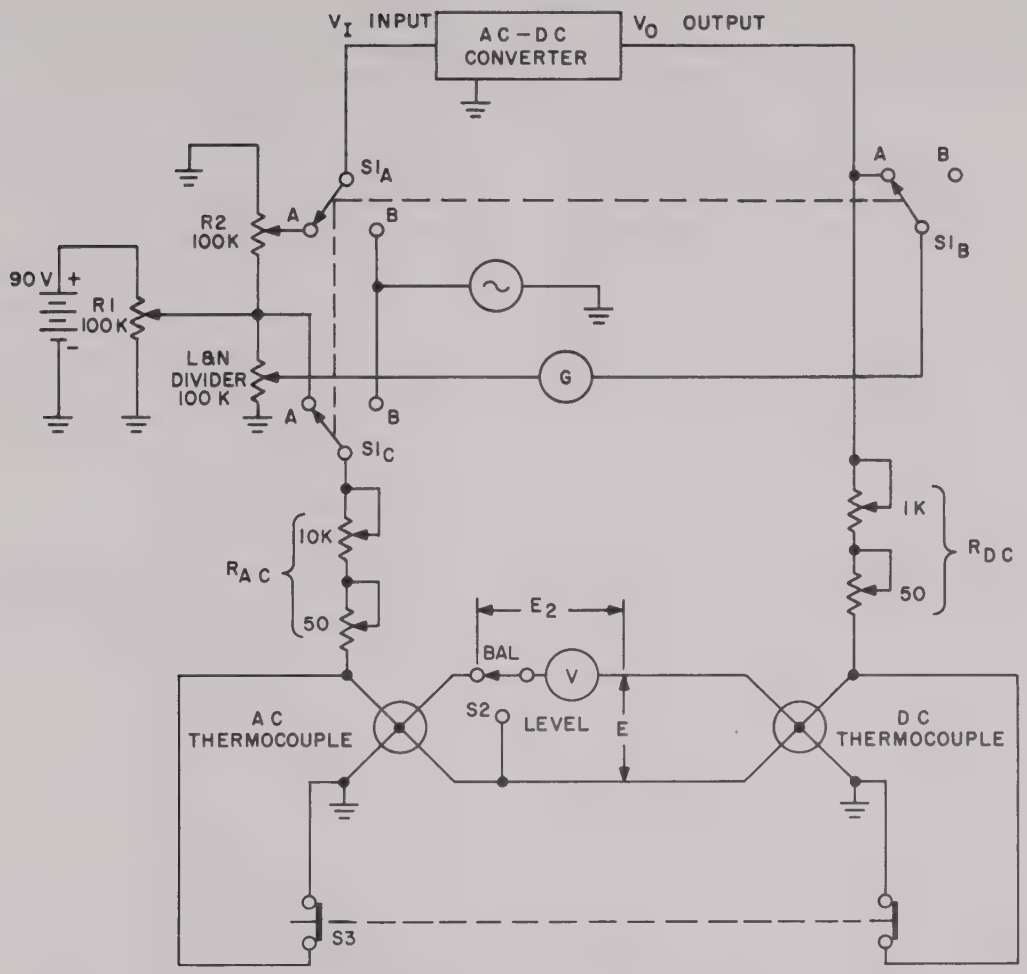


Figure 11. Two Thermocouple Test Set-up, 100 and 1000 Volt Range

TABLE 8. 100 Volt Range Calibration Adjustments

V_1 (RMS VOLTS)	V_0 (VOLTS)	INPUT FREQUENCY (CPS)	ADJUSTMENTS	E_2 (MICROVOLTS)
90	9.000	2500	Adjust C6 on Resistor Network 12.223 (J1) for minimum value of E_2.	
90	9.000	2500	Adjust C8 on Resistor Network 12.223 (J1) for indicated value of E_2.	-2

(4) *1000 Volt Range Calibration.*

(a) Retain the 100 volt range test circuit (Figure 11).

(b) Repeat steps (b) through (i) as outlined for the 1 volt range except set the L & N Test Set for 0.100 (step c) and set R1 for V_0 = 1.1 volts (step d).

(c) Record $\Delta V_0\%$ versus frequency as indicated by the test chart. (Check and record the T.C. Zero Balance before and after recording the group data.) The value of $\Delta V_0\%$ is calculated as follows: $\Delta V_0\% = E_2 (10^3)$; where E_2 is in microvolts.

(d) *If* the recorded values *are not* within tolerance make the adjustment indicated in Table 9. After adjustment repeat steps (b) and (c).

TABLE 9. 1000 Volt Range Calibration Adjustments

V_1 (RMS VOLTS)	V_0 (VOLTS)	INPUT FREQUENCY (CPS)	ADJUSTMENTS	E_2 (MICROVOLTS)
110	1.100	1000	Adjust C12 on Resistor Network 12.223 (J1) for indicated value of E_2.	-0.35

Comparison Method:

The comparison method requires an AC-DC Converter 49.001 that has been calibrated by the two-thermocouple method and has a complete set of accurately recorded data for all frequencies on all ranges. This calibrated converter is used as a *standard* to which any number of converters may be compared and calibrated.

NOTE: *Do not make any adjustments on the standard unit. If an adjustment is changed the converter must be recalibrated by the two thermocouple method and all readings repeated.*

(1) Set up the test circuit shown on Figure 12.

(2) Record $\Delta V_0\%$ of the unknown unit for all ranges and frequencies as indicated on the test chart (Figure 8). $\Delta V_0\%$ for the unknown unit is calculated as follows: $\Delta V_0\% = 10\ E_D + \Delta V_0\%$ of known unit (where E_D is the difference in the output between the two units as measured in *millivolts)*.

(3) If the percent error of full scale ($\Delta V_0\%$) is not within the required tolerance on a range, make the appropriate adjustments as given in Tables 7 through 9 of the two-thermocouple method.

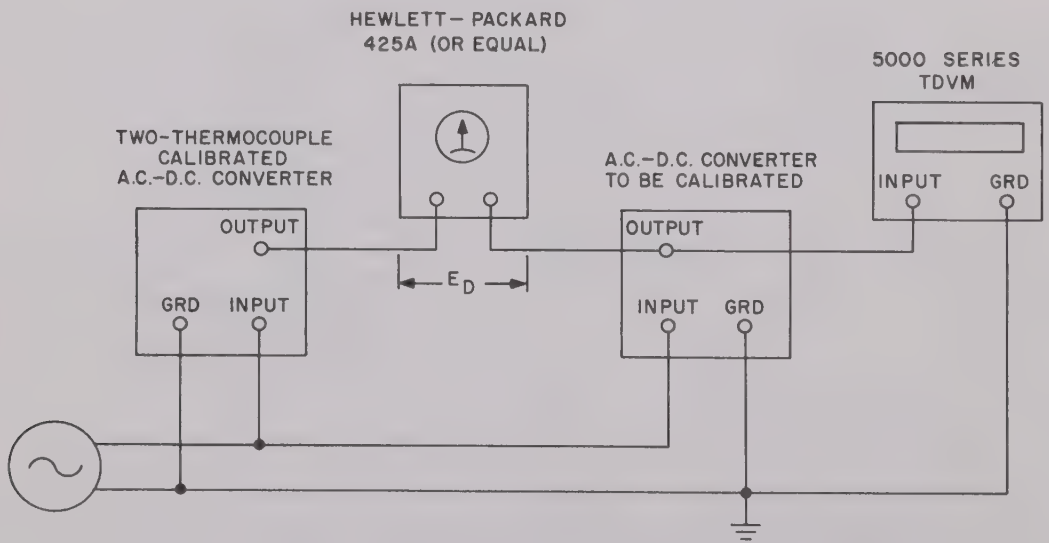


Figure 12. Comparison Method Calibration Test Set-Up

7. MAINTENANCE

The AC-DC Converter 49.001 is designed for long-life and trouble-free operation. In general, the frequent checks of the amplifier balance and a periodic check of the d-c calibration (outlined in this section) will maintain this precision instrument in peak operating condition.

In the case of an actual equipment failure, standard trouble-shooting procedures should be employed. The information given in this paragraph is only intended as a guide for maintenance personnel and should not be considered as a substitute for a thorough understanding of the instruments' operation.

a. D-C Gain Check

A simple d-c gain measurement rapidly checks the accuracy of the converter. The dependibility of this check, however, is dependent on the accuracy of the d-c voltage source. Since the converter is calibrated to produce a d-c output proportional to the RMS value of the a-c input, the output of the converter for a square wave or d-c input must be multiplied by the factor $2\sqrt{2}/\pi$. Also, because each range is scaled to produce an output between 0 and +10 volts, the output must be multiplied by a suitable scaling constant. Table 10 lists the various multiplication factors for each range.

TABLE 10. Range D-C Multiplication Factors

RANGE	SCALE-CONSTANT	RANGE MULTIPLICATION FACTOR
1 volt	10	$\frac{2\sqrt{2}}{\pi}$ (10) = 9.0032
10 volt	1	$\frac{2\sqrt{2}}{\pi}$ (1) = 0.90032
100 volt	$\frac{1}{10}$	$\frac{2\sqrt{2}}{\pi}$ $\frac{1}{10}$ = 0.090032
1000 volt	$\frac{1}{100}$	$\frac{2\sqrt{2}}{\pi}$ $\frac{1}{100}$ = 0.0090032

By applying a positive d-c input the entire converter is checked out. Should and error exist, apply a negative input. This effectively removes amplifier 1B from the circuit (by clamping action of CR1). Elimination of the error indicates that 1B is defective.

If a low frequency square wave of equal-magnitude positive and negative peaks is used, and the output of the converter is monitored with a scope, inaccuracies in amplifier 1B may readily be detected (a display magnitude-change in the scope trace, at the frequency of the square wave, indicates trouble in amplifier 1B).

b. Trouble Analysis Checks, Symptoms, and Causes

Table 11 lists various check points throughout the converter and the voltage that should be present at each point. The potentials as listed are measured with respect to chassis ground with the unit on the 1 volt range and a 1 volt RMS a-c signal applied to the input.

Trouble in the amplifier circuits may often be isolated to a specific amplifier by checking the balance adjustments (this check must always be made starting with 1 and in ascending order to 4). Inability to balance an amplifier indicates that the unit is faulty.

Interchanging of similar printed circuit cards either internally, or with another unit will often isolate faulty circuits.

NOTE: *The Dual D. C. Amplifier 6.334-2 cards may be interchanged for trouble analysis; however, permanent interchange is not recommended without complete d-c and a-c calibration of the instrument.*

TABLE 11. Converter Voltage Check Points

Circuit	Check Point	A-C Voltage (Volts)	D-C Voltage (Volts)
1. Power Supply Regulator	Power Supply Regulator connector pin: C H S		 +30 +15 -15
2. Output of amplifier 1B	Junction of diode CR2, resistor R3, and resistor R4.	See Figure 2	See Figure 2
3. Output of amplifier 1A	Pin X of Amplifier Network 12.209 (J3)	See Figure 2	See Figure 2
4. Output of amplifier 2B	Pin B of Amplifier Network 12.209 (J3)		-4.5
5. Output of amplifier 2A	OUTPUT connector		+10

If the converter produces a negative output when a positive d-c is applied to the input, amplifier 1B or associated circuitry is faulty (possibly CR2 or RANGE switch contacts).

c. Component Location Diagrams

These diagrams are included in the manual to aid maintenance personnel to readily locate printed circuit cards or individual components within the instrument. Figures 13 and 14 show the location of the various printed circuit cards within the converter chassis. Figures 15 through 19 show the location of the individual components on each of the printed circuit cards and Figure 20 shows the location of components on the rear of the meter.

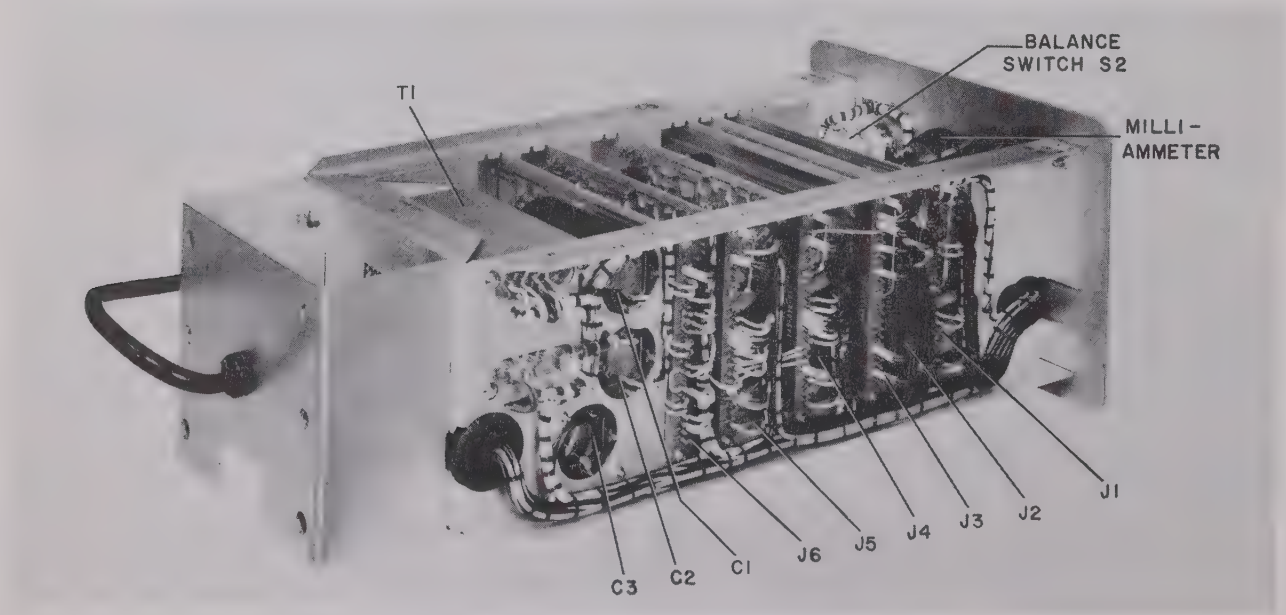


Figure 13. Chassis Component Location, Left-Rear View

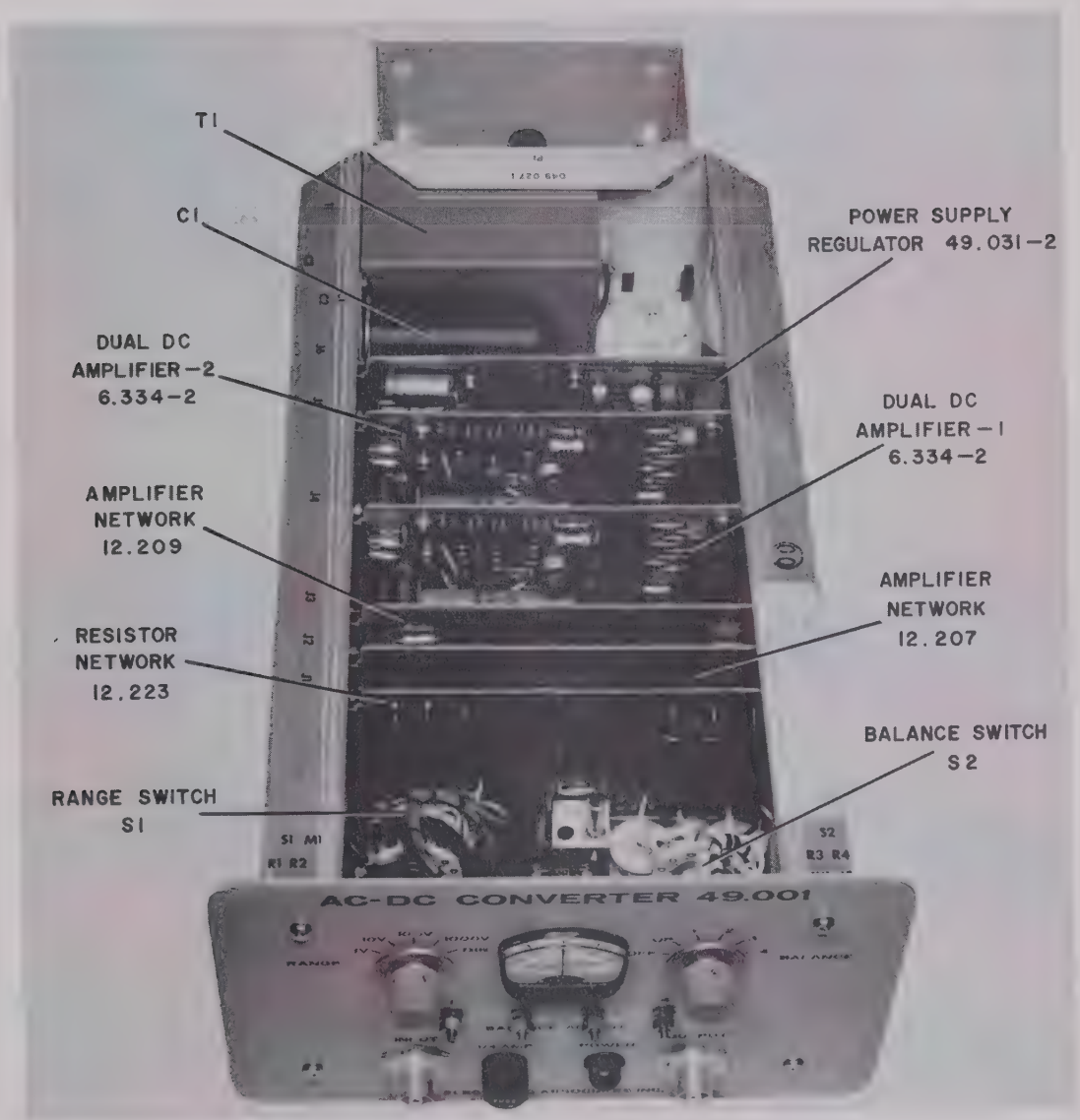
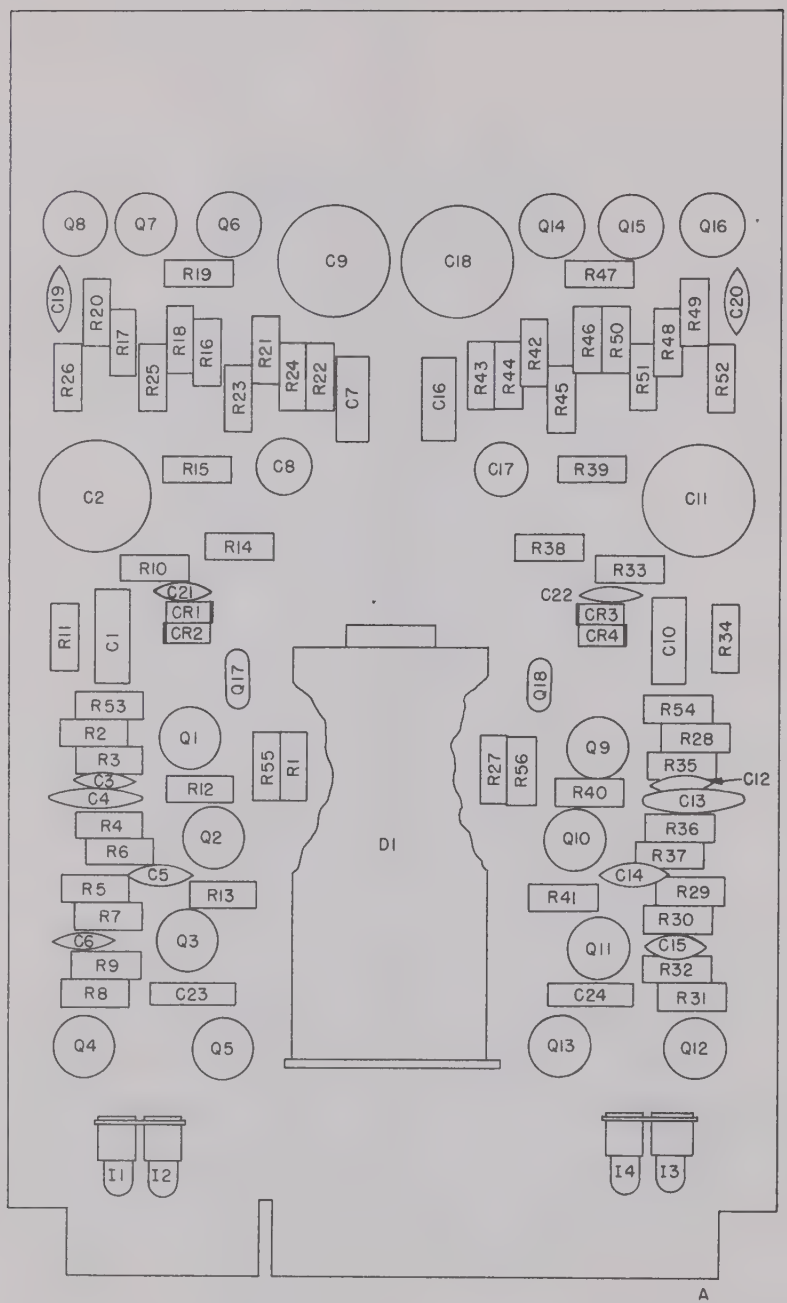


Figure 14. Chassis Component Location, Three-Quarter Top View



PLUG-IN END OF CARD

Figure 15. Dual D.C. Amplifier 6.334-2, Component Location Diagram

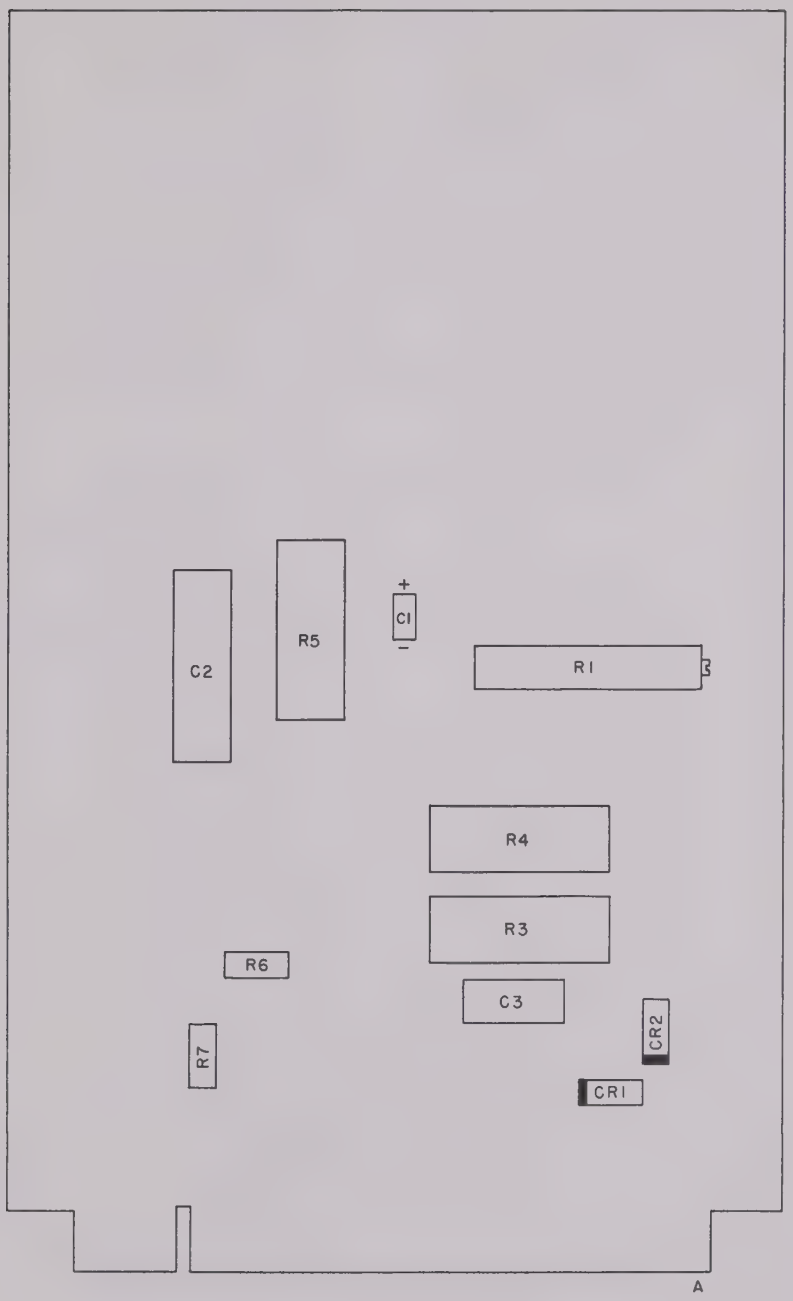


Figure 16. Amplifier Network 12.207, Component Location Diagram

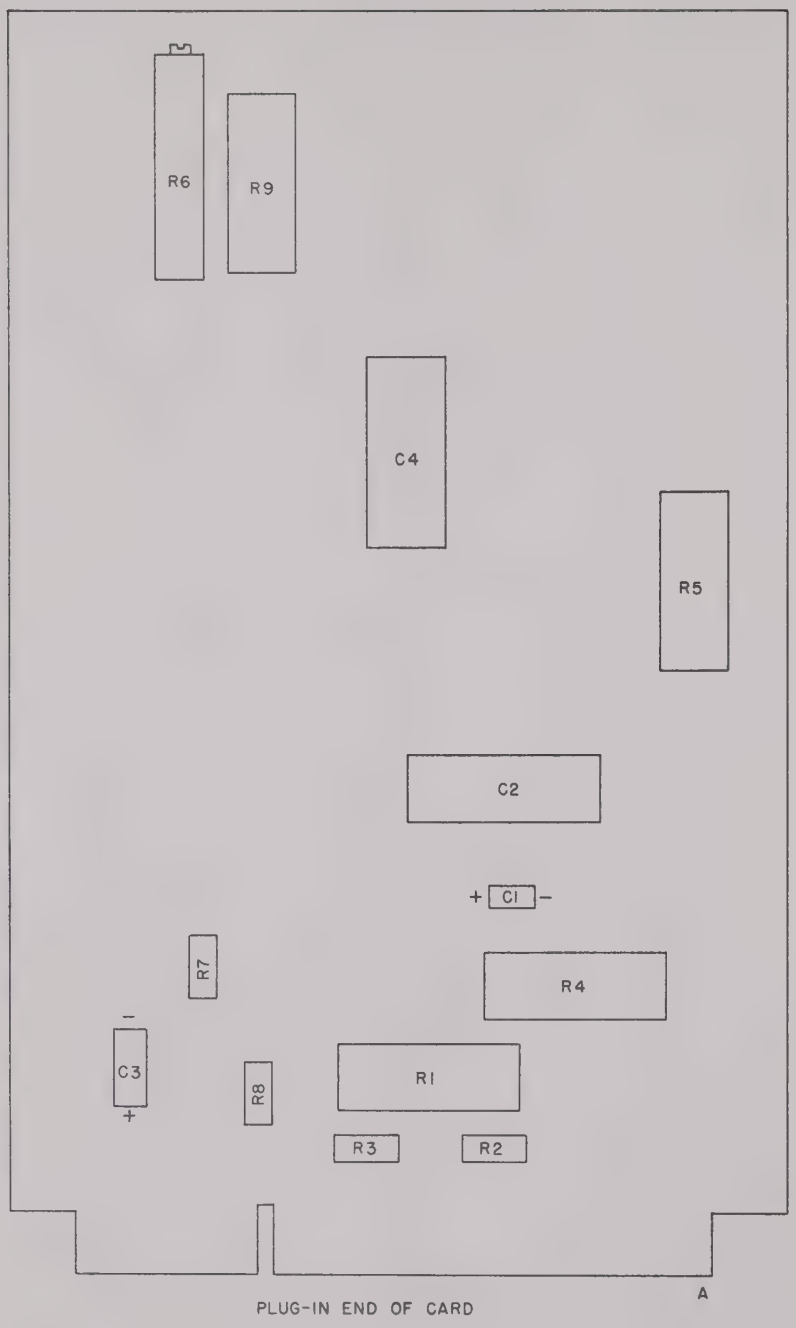


Figure 17. Amplifier Network 12.209, Component Location Diagram

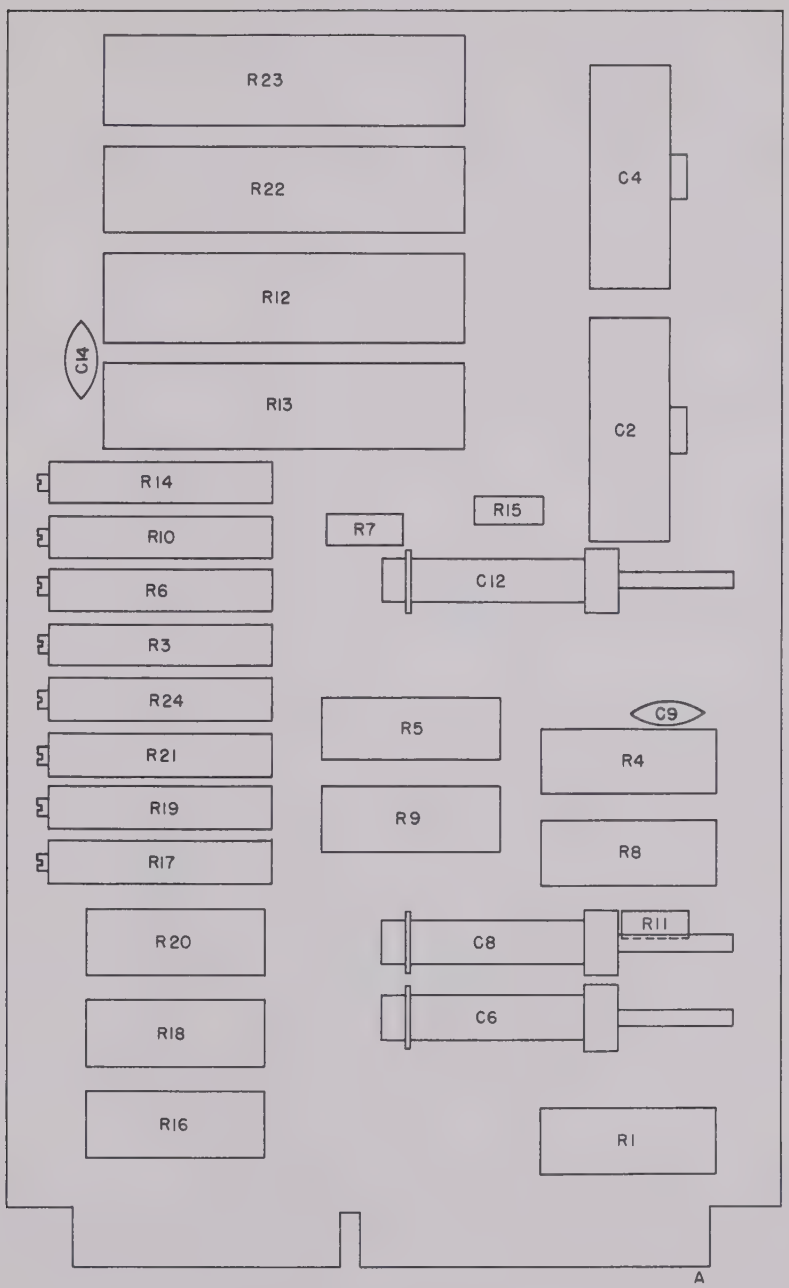


Figure 18. Resistor Network 12.223, Component Location Diagram

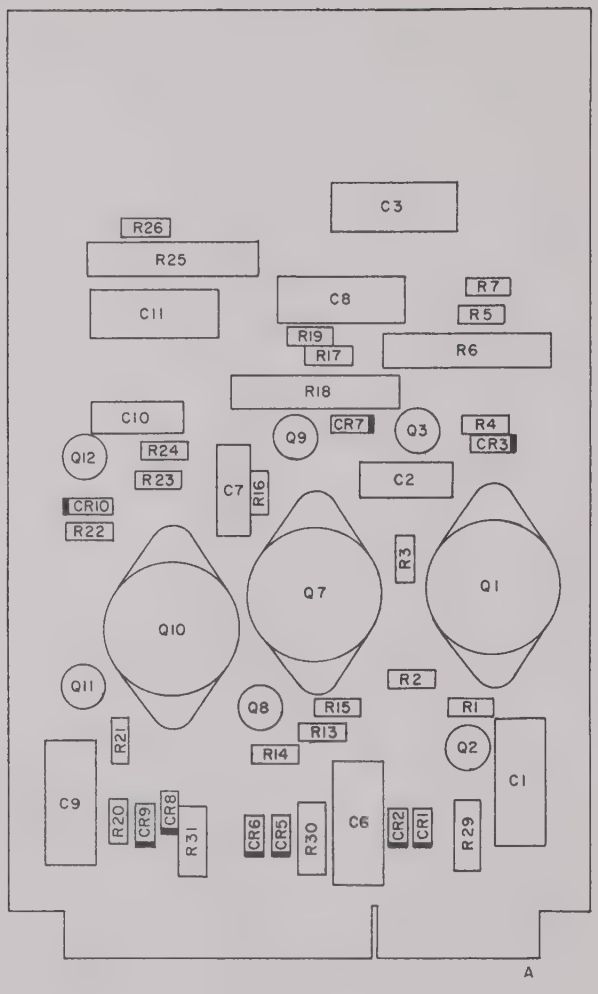


Figure 19. Power Supply Regulator 43.031, Component Location Diagram

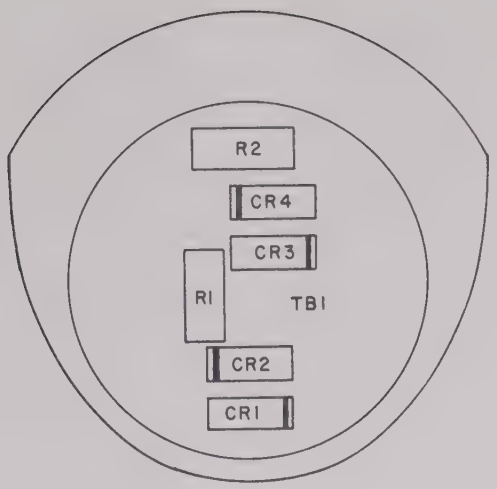


Figure 20. Meter and Protective Network 49.030, Component Location Diagram

8. SERVICING TECHNIQUES

a. Printed Circuit Servicing Techniques

The repair procedures in this section are offered for maintenance personnel unfamiliar with servicing printed-circuit assemblies. It is suggested that these techniques be used to avoid damaging the printed-circuit boards when repair or component replacement is necessary.

(1) To replace wire leads or components fastened to the board with axial leads, use diagonal cutters which enable the solder fillet and leads to be cut flush with the surface of the conductor. To install the new component, bend the leads and insert into the board holes. When soldering hold the tip of the iron in contact with the end of the lead so that solder runs down the lead and forms a smooth fillet on the surface of the conductor. Use a small, well-tinned, 35 or 40 watt soldering iron and work quickly to avoid damage to the board or component. The soldering process can be accomplished rapidly by having both surfaces well tinned and using a relatively soft solder such as a 60/40 type, low-temperature solder. Do not heat the surface of the conductor directly as this causes the conductor and the base to separate.

(2) Components with stiff leads or terminals (such as potentiometers, sockets, electrolytic capacitors, etc.) are best removed by clipping each terminal with the diagonal cutting pliers. If this is difficult or undesirable, heat each joint individually and brush away the melted solder with a small stiff-bristle brush. When all solder has been removed in this manner, the component may be easily removed.

(3) If a conductor opens due to a break or an overload, the gap may be bridged with a piece of tinned bus wire. The wire should be carefully soldered across the open section.

b. Transistor Circuit Servicing Techniques

Servicing and trouble-shooting procedures applicable to transistorized circuitry are in many ways similar to techniques used in vacuum tube circuits. However, certain precautions must be observed when trouble-shooting, repairing, or replacing components in transistor circuits. It is felt that the suggestions and techniques outlined in the following paragraphs may be of some assistance to maintenance personnel unfamiliar with servicing transistorized equipment.

(1) While practically all transistors are mechanically rugged, these units are easily damaged by excessive heat. If it becomes necessary to perform soldering operations in close proximity to a socket-mounted transistor, the transistor should be removed. In cases when the transistor is soldered directly to the circuit board, some form of heat shielding should be provided to keep the heat of the iron away from the transistor. In all cases the use of a hot, well-tinned iron (not larger than 35 or 40 watts) will enable the soldering operation to be performed rapidly.

If removal of a directly-soldered transistor is necessary, the transistor *must* be provided with some form of heat protection. This is best accomplished by grasping the leads with long-nose pliers between the body of the transistor and the heat source. The pliers function as a heat sink and should be kept on the lead for a short time after the iron is removed. In circuits where a socket is employed, the transistor should be removed before the soldering iron is applied to any of the socket terminals.

Power Transistors in amplifiers and power supplies are often mounted on metal chassis plates which function as heat sinks. Since the collectors of these transistors are generally operated at relatively high potentials, an insulating washer is required between the transistor body and the heat sink. When replacing any of these components, be certain that the washer and the plastic insulating sleeves provided for the mounting screws are in place. To further increase the insulating properties of the washer and to provide thermal conductivity, a light coating of silicone lubricant (Dow Corning 4 compound or equivalent) should be applied to both sides of the washer before installation. If desired, the lubricant may also be applied to the edges of the heat sink plate before fastening in place.

As a final precaution before power is applied to the repaired unit, connect an ohmmeter between the heat sink plate and the transistor body (collector), to ensure that no short or high-leakage path exists between these points.

(2) Transistors are quickly damaged by applying operating potentials of excessively high amplitude or incorrect polarity. Because of these limitations, socket-mounted transistors should never be removed or inserted while power is applied to the circuit. This precaution is necessary to prevent any surge or transient voltages, which may be generated during insertion or removal, from damaging the transistors.

Another potential source of transistor overload is in the incorrect use of a signal generator for trouble-shooting purposes. Many of the audio generators which may be used for this purpose are capable of supplying relatively high signal voltages which can damage or destroy a transistor particularly when applied to low-level stages. Always begin signal injection with the generator controls set for minimum output and then gradually increase the signal level until the desired results are achieved.

(3) When making continuity checks and resistance measurements in transistorized circuits, some precautions must be observed regarding the test meter used for this purpose. One factor which must be considered is the internal battery polarity used for the ohmmeter section of the instrument. Most commercial volt-ohmmeters or multi-testers use an arrangement where the *ohms* lead is connected to the positive terminal of the battery, with the ground or *common* lead connected to the negative side. However, in some instruments the reverse is true. Before connecting the meter to a transistorized circuit, the battery polarity should be determined. (This may be accomplished by connecting the ohmmeter leads to a low-range voltmeter.) Since transistor circuits utilize electrolytic capacitors with very low voltage-ratings (6 volts or less in some cases), false indications and capacitor damage may occur if the meter polarities are reversed. Another factor to be considered is the meter-battery voltage. Certain instruments use batteries with potentials of 6 volts or greater (up to 45 volts in some cases). Improper use of a meter of this type can easily ruin transistors and low-voltage electrolytic capacitors. For these reasons it is suggested that the ohmmeter section of a vacuum-tube voltmeter be used for resistance measurements in transistor circuits. Practically all of these instruments utilize a 1.5 or 3 volt battery for the ohmmeter with the positive side of the internal battery connected to the *ohms* lead, and the negative side connected to the instrument case or *common* lead.

(4) In the course of servicing an amplifier or power supply circuit, the transistor itself may be suspected of being defective. In this case, as in vacuum tube circuitry, the best check is to substitute the suspected transistor with a known good unit. Commercial transistor testers are available, but in some applications these instruments do not yield conclusive results. Substitution affords the most reliable check.

APPENDIX I

REPLACEABLE PARTS LISTS

This appendix lists all replaceable parts in the AC-DC Converter 49.001. In each case a brief description of the part and a manufacturer's number are listed. Where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index page precedes the individual spare parts lists.

The category column in the parts list is intended to indicate the availability of each listed part so that a replacement part can be obtained as quickly as possible. The components in category-A are standard electronic items that are usually available from any commercial electronic supplier. In order to expedite obtaining items of this nature, it is suggested that they be purchased from a local source whenever possible. If necessary these parts may be ordered from EAI.

The components in category-B are items that can be obtained from EAI or any of the listed manufacturers. However, in most cases EAI is in a position to offer the most rapid service on items in this category.

The parts in category-C are custom-made components and proprietary items that are available only from EAI. When ordering items of this type, please specify the type number and serial number of the basic unit in which the part is located, as well as the part identification.

Where possible, sufficient information is given for category-C items to permit an *electrically-similar* replacement part to be obtained locally. Thus, if desired, a temporary repair may be made while the *exact* replacement is being obtained from EAI. *Note, however, that EAI does not guarantee that the affected unit will operate within specifications when the specified category-C part is not used.*

PLEASE NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED: IN ALL CASES EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

AC - DC CONVERTER 49.001

	Model Number	Component	Page
1.	49.001	AC - DC Converter	AI-3
2.	6.334-2	Dual DC Amplifer	AI-4
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4.	12.209	Amplifier Network	AI-8
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6.	43.031-2	Power Supply Regulator	AI-11
7.	49.030	Meter and Protective Network	AI-13

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,2,3	Capacitor, Fixed, Electrolytic: 2500 UF, 25V; P.R. Mallory 20-20979	516 052 0	B
2	F1	Fuse, Cartridge, Slow Acting Type: 1/4 Amp, 125V; Littelfuse 313.250	570 102 0	A
3	I1	Lamp, Incandescent: General Electric 328	578 010 0	A
4	J1	Connector, Printed Circuit: 15 Contacts; Amphenol 143-015-01-1013	542 303 0	A
5	J2	Connector, Printed Circuit: 22 Contacts; Amphenol 143-022-01-1019	542 344 0	A
6	J3	Connector, Printed Circuit: 22 Contacts; Amphenol 143-022-01-1017	542 342 0	A
7	J4,5	Connector, Printed Circuit: 22 Contacts; Amphenol 143-022-01-1016	542 341 0	A
8	J6	Connector, Printed Circuit: 10 Contacts; Amphenol 143-010-01-1008	542 274 0	A
9	J7,8	Connector, R.F., Plug: Amphenol 82-515	542 728 0	A
10	P1	Connector, Plug: 32 Contacts; Cannon Electric DPD-32C2-34P-1L	542 114 0	A
11	R1,2,3,4	Resistor, Variable, Composition: 10K Ohms ± 20%, 1/2W; Allen-Bradley Type G	A642 364 0	A
12	R5	Resistor, Fixed, Composition: 10 Ohms ± 10%, 1W; Allen-Bradley GB	627 100 1	A
13	S1	Switch, Rotary Selector: Centralab PA-2023	658 025 0	A
14	S2	Switch, Rotary Selector: Centralab PA024-3460	B658 170 0	C
15	T1	Transformer, Power, Step-Down and Step-Up: Sterling Transformer Corp. ST-3311	B684 110 0	C
16		Connector, Receptacle: 32 Contacts; Cannon Electric DPD-32C2-33S-1L	542 112 0	A

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UNIT TITLE
AC-DC CONVERTER

MODEL NO.
49.001

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,10	Capacitor, Fixed, Electrolytic: 10 UF ± 20%, 50V; Sprague 109D106X0050C2	516 206 0	A
2	C2,9,11,18	Capacitor, Fixed, Electrolytic: 1250 UF, 3V; Callins Industries Type PSS	A516 184 0	B
3	C3,12	Capacitor, Fixed, Ceramic: 100 UUF ± 10%, 1,000V; Cornell-Dubilier L10T1	515 019 0	A
4	C4,13	Capacitor, Fixed, Ceramic: 4,700 UUF ± 20%, 1,000V; Cornell-Dubilier BYA10D47M	515 008 0	A
5	C5,14	Capacitor, Fixed, Ceramic: 47 UUF ± 10%, 1,000V; Cornell-Dubilier L10Q47	515 017 0	A
6	C6,15	Capacitor, Fixed, Ceramic: 330 UUF ± 20%, 600V; Cornell-Dubilier Type LA-S3	515 073 0	A
7	C7,16	Capacitor, Fixed, Electrolytic: 5 UF +20%-15%, 50V; Sprague 109D505C2050C0	516 185 0	A
8	C8,17	Capacitor, Fixed, Electrolytic: 5 UF, 25V; International Electronics Industries	B516 056 0	C
9	C19,20	Capacitor, Fixed, Ceramic: 1000 UUF ± 20%, 75V; Glenco Min-Z-1000-M	515 075 0	B
10	C21,22	Capacitor, Fixed, Ceramic: 12 UUF ± 10%, 1,000V; Cornell-Dubilier C10Q12C	515 091 0	A
11	C23,24	Capacitor, Fixed, Ceramic: .05 UF +100%-20%, 30V; Centralab DA-503	515 183 0	A
12	CR1 Thru 4	Rectifier, Silicon: Hughes HR10212	614 034 0	B
13	D1	Chopper: Coil: 6.3V, 60 CPS, Contacts: BBM, DPDT; James Electronics C-2335	530 042 0	C
14	I1 Thru I4	Lamp, Incandescent: 330 Type	578 020 0	A
15	Q1,2,3,9, 10,11	Transistor, Germanium: PNP; General Transistor Corp GT1236	B686 028 0	C
16	Q4,12	Transistor, Germanium: PNP; General Transistor Corp GT1361	686 029 0	C
17	Q5,13	Transistor, Germanium: NPN; General Transistor GT1442	A686 039 0	C

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UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
6.334-2 Sht. 1 of 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	Q6,8,14,15, 16	Transistor, Germanium: PNP; 2N324 Type	A686 032 0	A
19	Q17,18	Transistor, Germanium: NPN; 2N169A Type	686 036 0	A
20	R1,27	Resistor, Fixed, Composition: 1 Megohm ± 10%, 1/2W; Allen-Bradley EB	626 105 1	A
21	R2,28	Resistor, Fixed, Composition: 3.3K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 332 1	A
22	R3,35	Resistor, Fixed, Composition: 1.8K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 182 1	A
23	R4,18,36, 50	Resistor, Fixed, Composition: 2.2K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 222 1	A
24	R5,29	Resistor, Fixed, Composition: 1.6K Ohms ± 5%, 1/2W; Allen-Bradley EB	626 162 0	A
25	R6,37	Resistor, Fixed, Composition: 7.5K Ohms ± 5%, 1/2W; Allen-Bradley EB	626 752 0	A
26	R7,30	Resistor, Fixed, Composition: 100 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 101 1	A
27	R8,31	Resistor, Fixed, Composition: 5.1K Ohms ± 5%, 1/2W; Allen-Bradley EB	626 512 0	A
28	R9,32	Resistor, Fixed, Composition: 56 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 560 1	A
29	R10,33	Resistor, Fixed, Composition: 4.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 472 1	A
30	R11,14,15, 16,17,34,38 39,46,48	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
31	R12,40	Resistor, Fixed, Composition: 33K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 333 1	A
32	R13,41	Resistor, Fixed, Composition: 6.2K Ohms ± 5%, 1/2W; Allen-Bradley EB	626 622 0	A
33	R19,20,47, 49	Resistor, Fixed, Composition: 220 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 221 1	A
34	R21,22,42, 43	Resistor, Fixed, Composition: 22K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 223 1	A

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UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
6.334-2 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
35	R23,45	Resistor, Fixed, Composition: 120K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 124 1	A
36	R24,44	Resistor, Fixed, Composition: 10 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 100 1	A
37	R25,26,51, 52,53,54	Resistor, Fixed, Composition: 68K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 683 1	A
38	R55,56	Resistor, Fixed, Composition: 4.7 Megohms ± 10%, 1/2W; Allen-Bradley EB	626 475 1	A

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UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
6.334-2 Sht. 3

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Electrolytic: 4.7 UF ± 10%, 6V; PR Mallory "TAS"	516 203 0	A
2	C2	Capacitor, Fixed, Plastic: .15 UF ± 5%, 150V; Gudeman 338Y154J	521 045 1	B
3	C3	Capacitor, Fixed, Ceramic: 12 μμF ± 10%, 500V; Erie Resistor Corp GP1K-12 ± 1.2	515 025 0	A
4	CR1,2	Diode, Silicon: Continental Device Corp CD1111	B614 103 0	B
5	R1	Resistor, Variable, Wirewound: 50 Ohms ± 10%, .25W; Bourns 200P-1-500	642 313 0	A
6	R3,5	Resistor, Fixed, Wirewound, Precision: 25,000 Ohms ± .05%; Julie Research Labs R34	A638 532 0	C
7	R4	Resistor, Fixed, Wirewound, Precision: 12,475 Ohms ± .05%; Julie Research Labs R34	A638 530 0	C
8	R6	Resistor, Fixed, Composition: 1K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 102 1	A
9	R7	Resistor, Fixed, Composition: 560 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 561 1	A

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UNIT TITLE
AMPLIFIER NETWORK

MODEL NO.
12.207

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,3	Capacitor, Fixed, Electrolytic: 10 UF ± 10%, 6V; P.R. Mallory "TAS"	516 205 0	A
2	C2	Capacitor, Fixed, Plastic: 1 UF ± 5%, 150V; Southern Electronics Corp MMYW-1-5-150TF	A521 120 0	C
3	C4	Capacitor, Fixed, Plastic: .68 UF ± 5%, 150V; Gudeman 338Y684J	521 049 1	B
4	R1,4	Resistor, Fixed, Wirewound, Precision: 25,000 Ohms ± .05%; Julie Research Labs R34	A638 532 0	C
5	R2	Resistor, Fixed, Composition: 1.2K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 122 1	A
6	R3,8	Resistor, Fixed, Composition: 560 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 561 1	A
7	R5	Resistor, Fixed, Wirewound, Precision: 5,458 Ohms ± .05%; Julie Research Labs R34	A638 529 0	C
8	R6	Resistor, Variable, Wirewound: 200 Ohms ± 10%, .25W; Bourns 200P-1-201	642 315 0	A
9	R7	Resistor, Fixed, Composition: 1K Ohm ± 10%, 1/2W; Allen-Bradley EB	626 102 1	A
10	R9	Resistor, Fixed, Wirewound, Precision: 12,500 Ohms ± .05%; Julie Research Labs R34	A638 531 0	C

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UNIT TITLE
AMPLIFIER NETWORK

MODEL NO.
12.209

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor, Fixed, Ceramic: 220 μμF ± 10%, 500V; Erie Resistor Corp GP2K-220 ± 22	515 042 0	A
2	C2,4	Capacitor, Variable, Ceramic: 20-125 UUF, 600V; Centralab 823-AN	524 007 0	B
3	C6,8,12	Capacitor, Variable, Glass: .6-14 UUF, 1000V; J.F.D. Electronics Corp VC-11G	524 003 0	A
4	C9	Capacitor, Fixed, Ceramic: 10 UUF ± 10%, 500V; Erie Resistor Corp GP1K-10±1	515 024 0	A
5	C10	Capacitor, Variable, Glass: .7-4.5 UUF, 1000V; J.F.D. Electronics Corp VC-2	524 004 0	A
6	C13	Capacitor, Fixed, Ceramic: 330 UUF ± 10%, 500V; Erie Resistor Corp GP2K-330±33	515 044 0	A
7	C14	Capacitor, Fixed, Ceramic: 5 UUF ± 10%, 500V; Erie Resistor Corp. GP1K-5 ± .5	515 023 0	A
8	R1,16	Resistor, Fixed, Wirewound, Precision: 5,000 Ohms +0%-.05%; Julie Research Labs R34	A638 533 0	C
9				
10	R3,24	Resistor, Variable, Wirewound: 10K Ohms ± 10%, .25W; Bourns 200P-1-103	642 320 0	A
11	R4,5	Resistor, Fixed, Wirewound, Precision: 25,000 Ohms ± .05%; Julie Research Labs R34	A638 532 0	C
12	R6,21	Resistor, Variable, Wirewound: 1K Ohm ± 10%, .25W; Bourns 200P-1-102	642 317 0	A
13	R7	Resistor, Fixed, Composition: 10 Megohms ± 10%, 1/2W; Allen-Bradley EB	626 106 1	A
14	R8,9	Resistor, Fixed, Wirewound, Precision: 250,000 Ohms ± .05%; Julie Research Labs R34	A638 626 0	C
15	R10,19	Resistor, Variable, Wirewound: 100 Ohms ± 10%, .25W; Bourns 200P-1-101	642 314 0	A
16	R11	Resistor, Fixed, Composition: 47 Megohms ± 10%, 1/2W; Allen-Bradley EB	626 476 1	A

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UNIT TITLE
RESISTOR NETWORK

MODEL NO.
12.223 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	R12,13,22, 23	Resistor, Fixed, Wirewound, Precision (Matched Pair): 5,000,000 Ohms +0%-.05% Total Series Resistance	A638 536 0	C
18	R14,17	Resistor, Variable, Wirewound: 50 Ohms ± 10%, .25W; Bourns 200P-1-500	642 313 0	A
19	R15	Resistor, Fixed, Composition: 100 Megohms ± 10%, 1/2W; Allen-Bradley EB	626 107 1	A
20	R18	Resistor, Fixed, Wirewound, Precision: 50,000 Ohms +0%-.05%; Julie Research Labs R34	A638 534 0	C
21	R20	Resistor, Fixed, Wirewound, Precision: 500,000 Ohms +0%-.05%; Julie Research Labs R34	A638 535 0	C

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UNIT TITLE
RESISTOR NETWORK

MODEL NO.
12.223 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,3,6,8,9, 11	Capacitor, Fixed, Electrolytic: 50 UF, 25V; Sprague TE-1209	516 149 0	A
2	C2,7,10	Capacitor, Fixed, Electrolytic: 10 UF, 12V; Sprague TE-1128	516 150 0	A
3	C4,12	Capacitor, Fixed, Electrolytic: 30 UF, 15V; Sprague TE-1158	516 039 0	A
4	C5	Capacitor, Fixed, Electrolytic: 110 UF, 3V; Sprague TE-1060	516 043 0	A
5	CR1,2,5,6, 8,9	Rectifier, Silicon: Pacific Semi-Conductors PS005	614 035 0	B
6	CR3,7,10	Diode, Silicon, Zener: 1N754 Type	614 046 0	B
7	CR4,11	Diode, Silicon, Zener: 1N1315A Type	614 010 0	B
8	Q1,7,10	Transistor, Germanium: PNP; 2N235A Type	686 034 0	A
9	Q2,3,8,9, 11,12	Transistor, Germanium: PNP; 2N324 Type	686 005 0	A
10	Q4,5,6	Transistor, Germanium: PNP; 2N321 Type	686 004 0	A
11	R1,2,13,14, 20,21	Resistor, Fixed, Composition: 4.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 472 1	A
12	R3,15,22	Resistor, Fixed, Composition: 10K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 103 1	A
13	R4,16,23	Resistor, Fixed, Composition: 1K Ohm ± 10%, 1/2W; Allen-Bradley EB	626 102 1	A
14	R5,7,17, 19,24,26	Resistor, Fixed, Composition: 560 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 561 1	A
15	R6,18,25	Resistor, Variable, Wirewound: 200 Ohms ± 10%, .25W; Bourns 266-1-201	642 327 0	B
16	R8	Resistor, Fixed, Composition: 620 Ohms ± 5%, 1/2W; Allen-Bradley EB	626 621 0	A
17	R9	Resistor, Fixed, Composition: 300 Ohms ± 5%, 1/2W; Allen-Bradley EB	626 301 0	A
18	R10	Resistor, Fixed, Wirewound: 100 Ohms ± 5%, 5W; Ward Leonard 5X100	636 056 0	A

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UNIT TITLE
POWER SUPPLY REGULATOR

MODEL NO.
43.031 -2 Sht. 1 of 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
19	R11	Resistor, Fixed, Composition: 1100 Ohms ± 5%, 1/2W; Allen-Bradley EB	626 112 0	A
20	R12	Resistor, Fixed, Composition: 200 Ohms ± 5%, 1/2W; Allen-Bradley EB	626 201 0	A
21	R27	Resistor, Fixed, Composition: 47 Ohms ± 10%, 2W; Allen-Bradley HB	628 470 1	A
22	R28	Resistor, Fixed, Composition: 2K Ohms ± 5%, 1/2W; Allen-Bradley EB	626 202 0	A
23	R29,30,31	Resistor, Fixed, Wirewound: 20 Ohms ± 5%, 3W; Ward Leonard 3X20	636 265 0	A

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UNIT TITLE
POWER SUPPLY REGULATOR

MODEL NO.
43.031-2 Sht. 2

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1 Thru 4	Diode, Silicon: 1N459 Type	614 007 0	A
2	M1	Meter, D.C. Micro Ammeter: 0 To 100 Micro-amps, Zero Center, D.C; (Customized Marion Instrument MM1 or equal)	B590 036 0	C
3	R1	Resistor, Fixed, Composition: 2.7K Ohms ± 10%, 1/2W; Allen-Bradley EB	626 272 1	A
4	R2	Resistor, Fixed, Composition: 470 Ohms ± 10%, 1/2W; Allen-Bradley EB	626 471 1	A

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UNIT TITLE
METER AND PROTECTIVE NETWORK

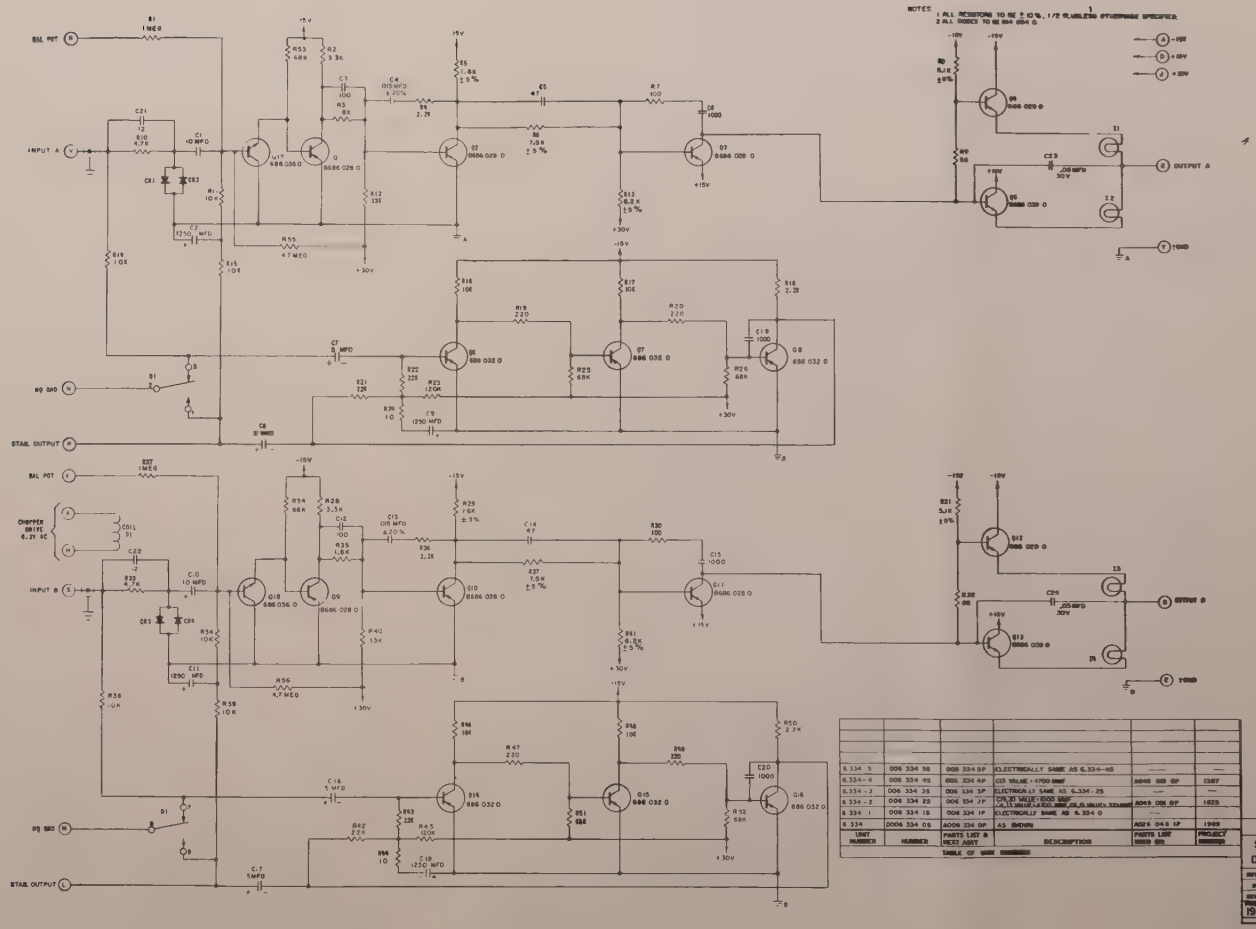
MODEL NO.
49.030

APPENDIX II

DRAWINGS

This appendix contains all of the schematic and wiring drawings necessary to maintain the AC-DC Converter 49.001.

Drawing Number	Title
D006 334 0S	Dual D.C. Amplifier, Schematic Diagram
C012 207 0S	Amplifier Network (J2), Schematic Diagram
C012 209 0S	Amplifier Network (J3), Schematic Diagram
C012 223 0S	Resistor Network (J1), Schematic
A019 088 0A	Converter Input-Output Cable, Assembly and Wiring Diagram
B019 149 0A	Converter Power and Patching Cable, Assembly and Wiring Diagram
C043 031 0S (Sheet 2)	Power Supply Regulator, Schematic Diagram
D049 001 0S	AC-DC Converter, Simplified Schematic Diagram
D049 001 0W (Sheet 1)	AC-DC Converter, Wiring Diagram
B049 001 0H	AC-DC Converter (Keysheet), Information Drawing



6.334-5	006 334 56	006 334 9P	ELECTRICALLY SAME AS 6.334-05	—	—
6.334-4	006 334 46	006 334 4P	C23 VALUE =.0100 MFD	A049 018 0P	1367
6.334-3	006 334 36	006 334 3P	ELECTRICALLY SAME AS 6.334-25	—	—
6.334-2	006 334 26	006 334 2P	C23 VALUE=.0500 MFD R1,15 VALUE=4.02Ω, R88 OR R VALUE= 332Ω	A049 026 0P	1825
6.334-1	006 334 16	006 334 1P	ELECTRICALLY SAME AS 6.334-0	—	—
6.334	006 334 06	A006 334 0P	AS SHOWN	A026 040 1P	1969
UNIT NUMBER	NUMBER	PARTS LIST & NEXT ASSY	DESCRIPTION	PARTS LIST USED ON	PROJECT

TABLE OF UNIT NUMBERS

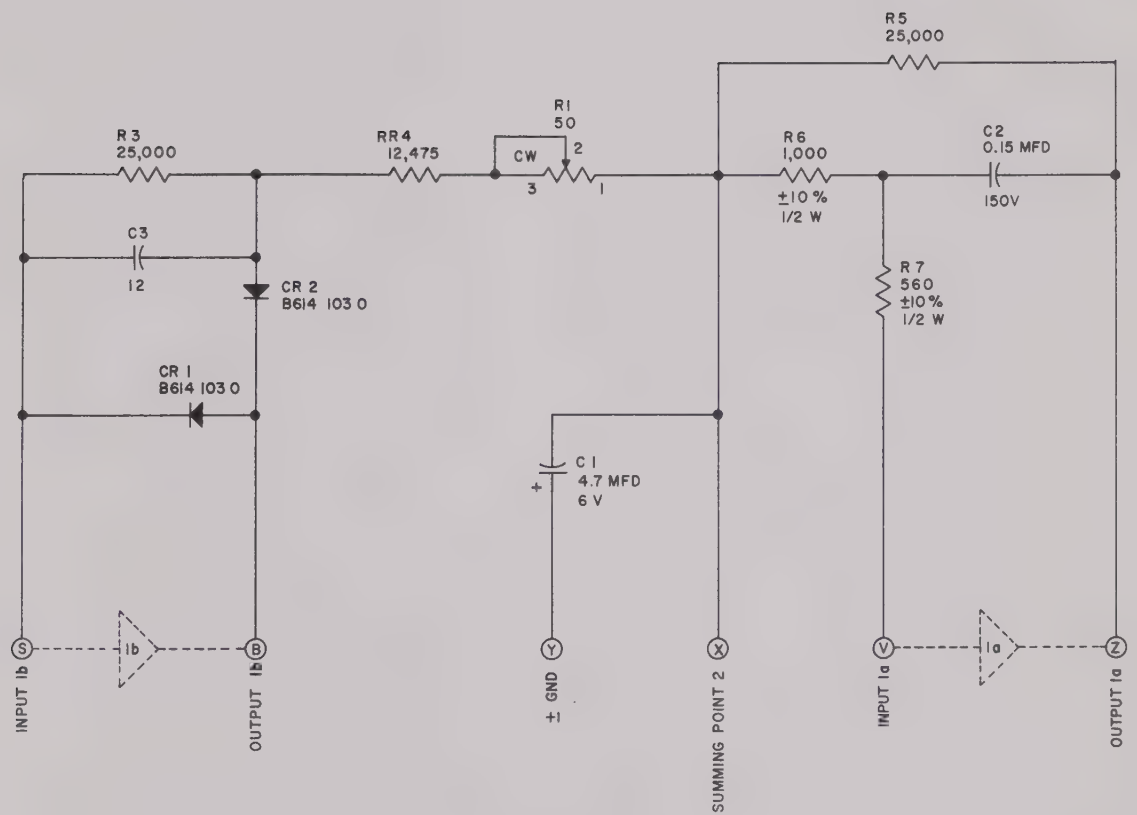
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC DIAGRAM
DUAL D.C. AMPLIFIER

DWG NO.	
SIZE	
SCALE	
DATE	1969

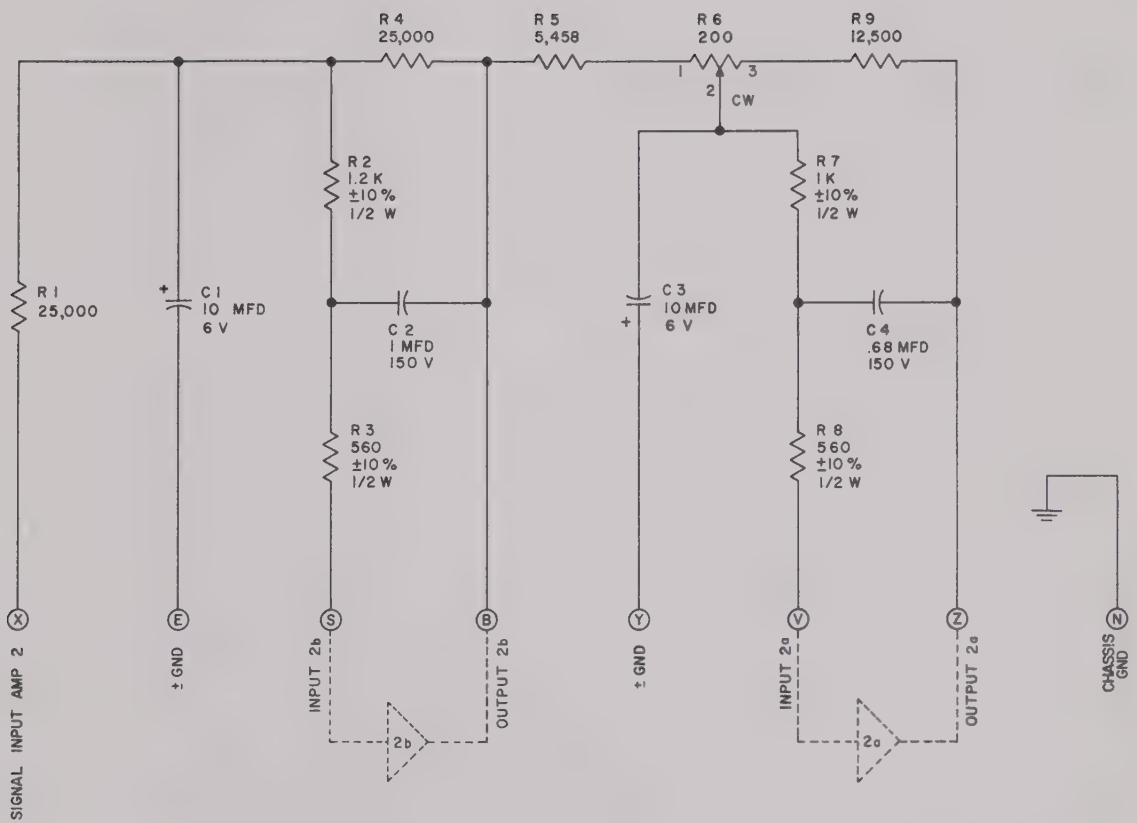
D 006 334 05

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ±.05%



ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC DIAGRAM AMPLIFIER NETWORK	
SHT. NO.	
SIZE	
REV NO	
PROJECT 1825	C012 207 0S
SHEET / OF / SHEETS	

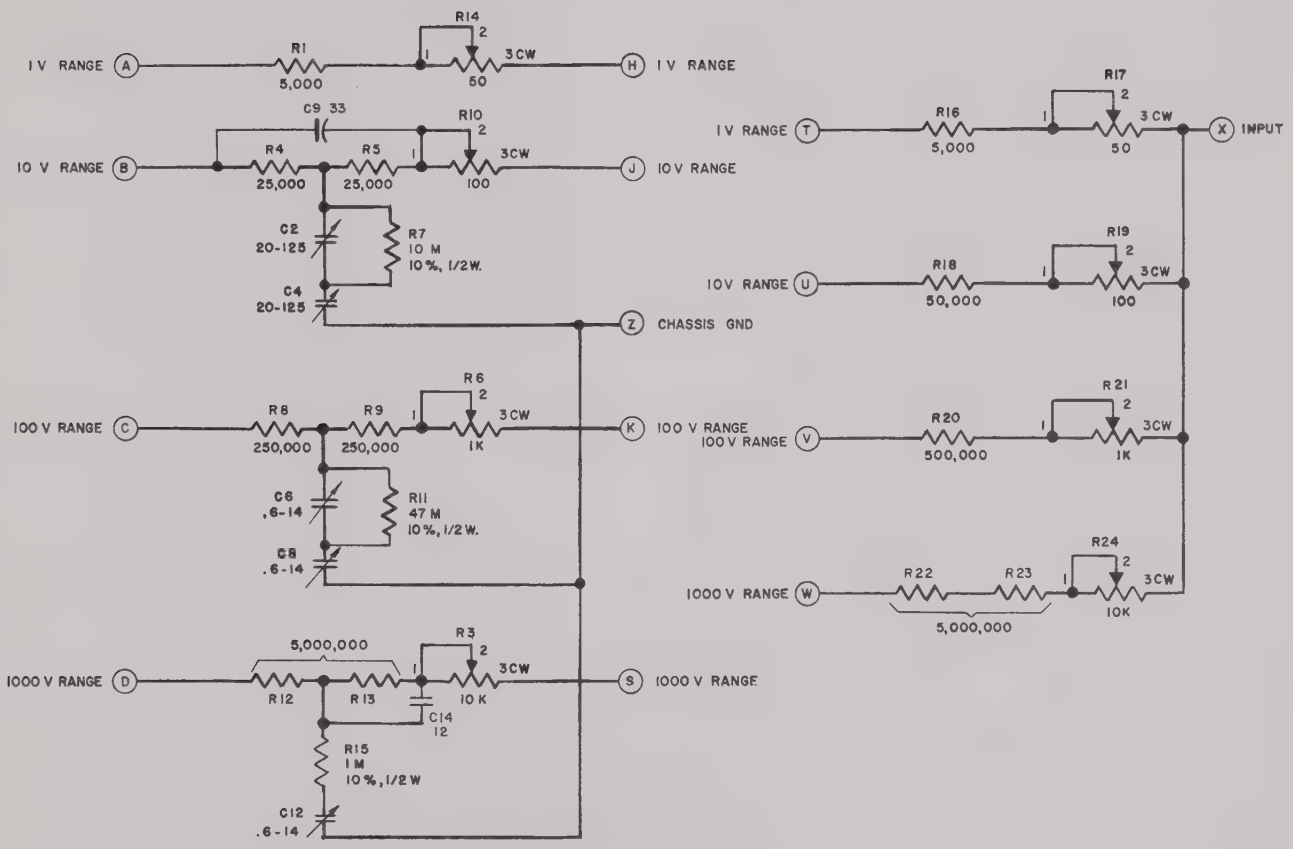
NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ±.05%



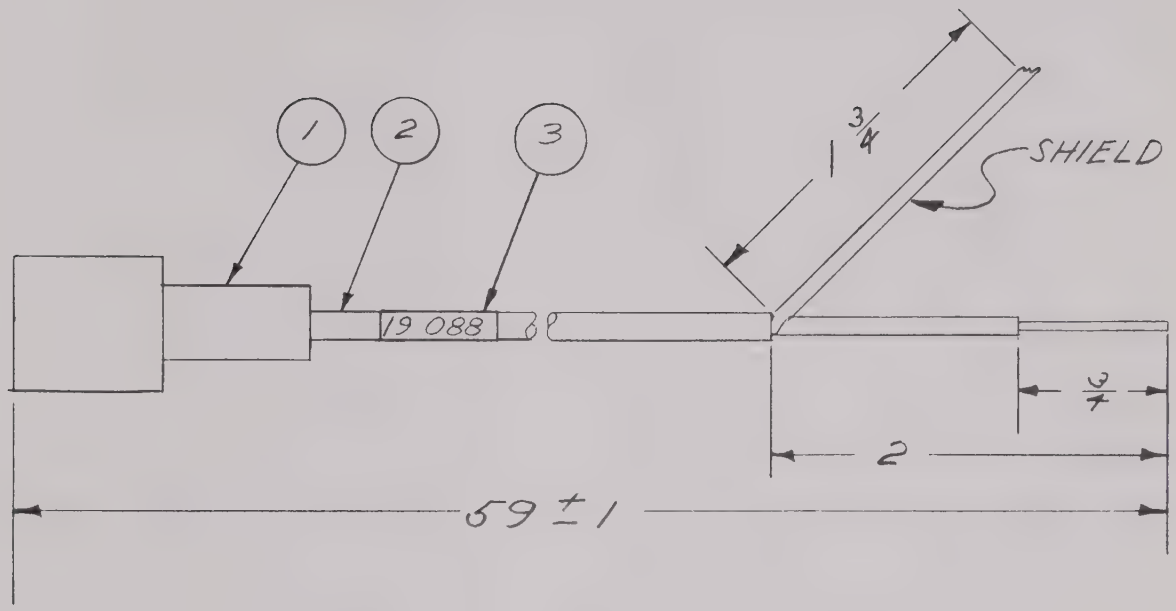
ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC DIAGRAM AMPLIFIER NETWORK	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1825	C012 209 0S
SHEET 1 OF 1 SHEETS	

NOTES:

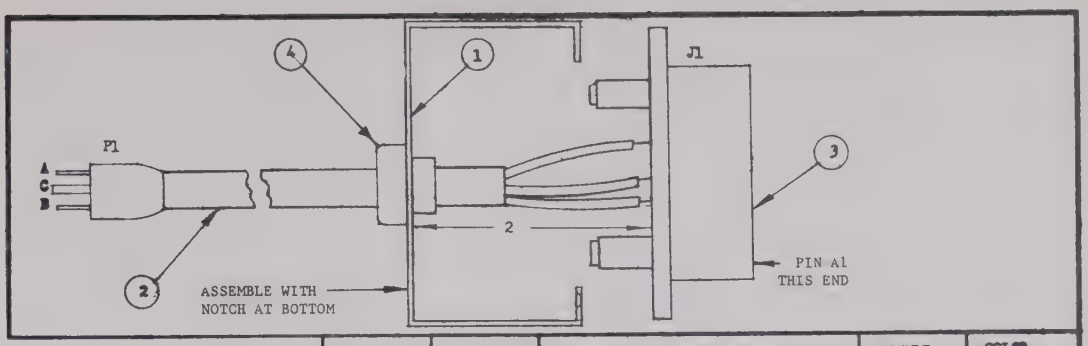
1. UNLESS OTHERWISE SPECIFIED ALL FIXED RESISTORS ARE ±.05%.



ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC RESISTOR NETWORK	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1825	C012 223 0S
SHEET / OF / SHEETS	



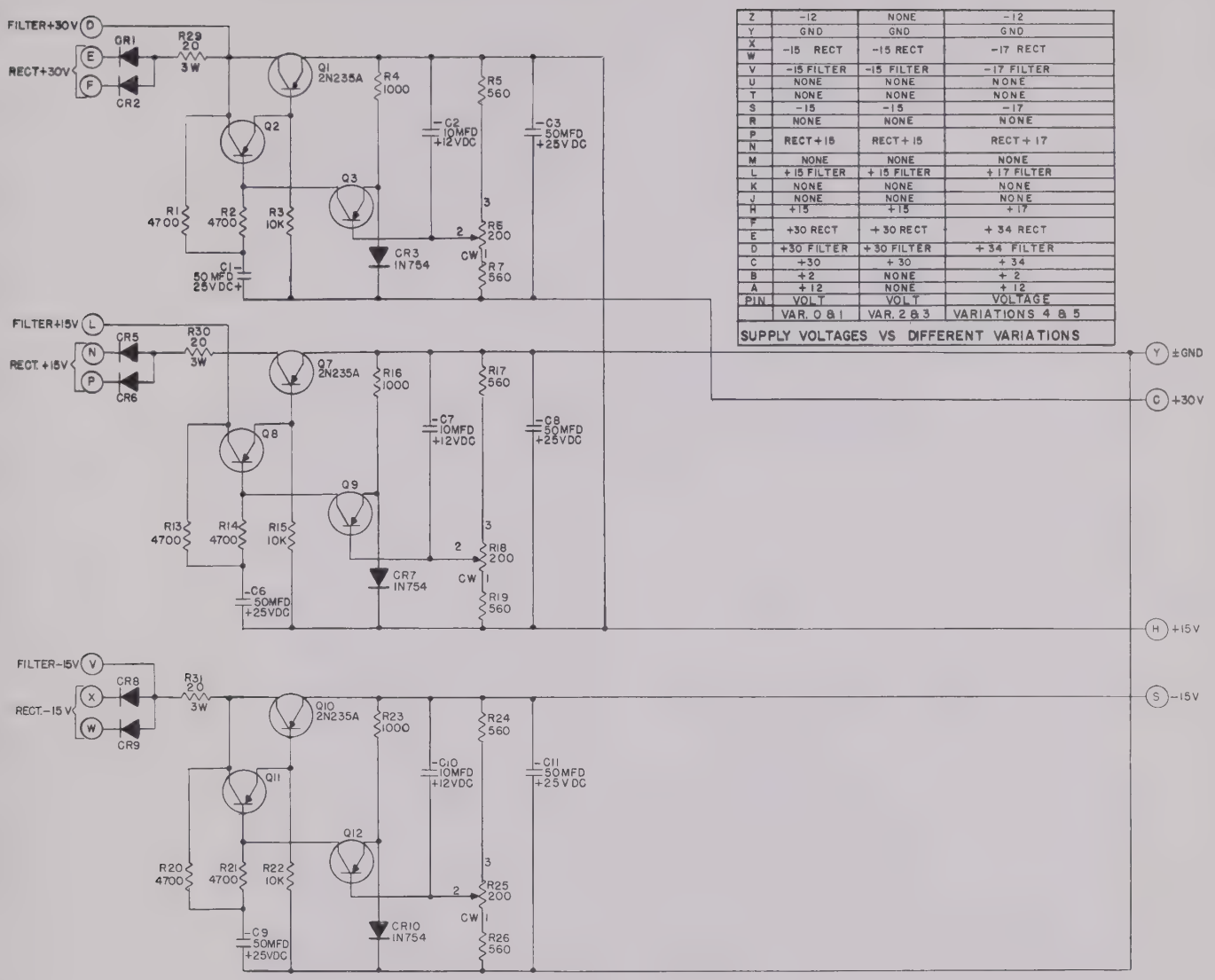
ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
ASSEMBLY DVM TEST CABLE	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1969	A019 088 0A
SHEET 1 OF 1 SHEETS	



TERMINAL	DESTINATION	IDENTIFICATION	WIRE	COLOR
J1-2	J1-29	HQ GND	SD-BUS 20	
J1-1	J1-16	± Gnd	SD-BUS 20	
J1-A1	-	Input		
-A2	-	Output		
-1	J1-2	Chassis Gnd	SD-BUS 20	
-2	P1-C	Chassis Gnd	*	GRN
-9	P1-B	Earth Gnd.	*	WH
-10	P1-A	Line Above Gnd	*	BLK
-11	J1-12	± Gnd	SD-BUS 20	
-12	J1-13	± Gnd	SD-BUS 20	
-13	J1-14	± Gnd	SD-BUS 20	
-14	J1-15	± Gnd	SD-BUS 20	
-15	J1-16	± Gnd	SD-BUS 20	
-26	J1-27	HQ Gnd	SD-BUS 20	
-27	J1-28	HQ Gnd	SD-BUS 20	
-28	J1-29	HQ Gnd	SD-BUS 20	

* POWER CORD ITEM 2

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
ASSEMBLY CABLE, POWER and PATCHING (AC DC CONVERTER)	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1825	B019 149 0A
SHEET OF SHEETS	



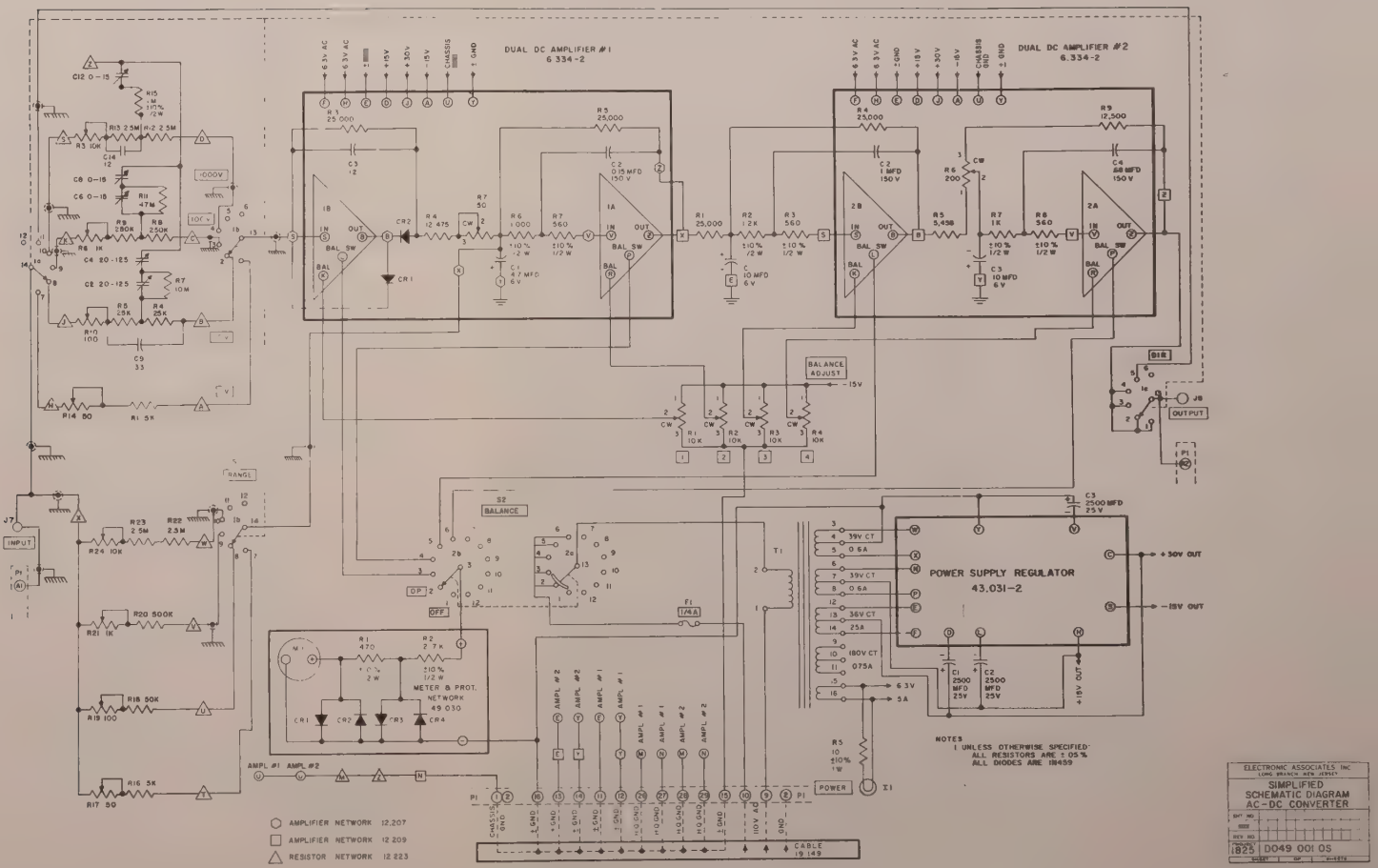
Z	-12	NONE	-12
Y	GND	GND	GND
X, W	-15 RECT	-15 RECT	-17 RECT
V	-15 FILTER	-15 FILTER	-17 FILTER
U	NONE	NONE	NONE
T	NONE	NONE	NONE
S	-15	-15	-17
R	NONE	NONE	NONE
P, N	RECT+15	RECT+15	RECT+17
M	NONE	NONE	NONE
L	+15 FILTER	+15 FILTER	+17 FILTER
K	NONE	NONE	NONE
J	NONE	NONE	NONE
H	+15	+15	+17
F, E	+30 RECT	+30 RECT	+34 RECT
D	+30 FILTER	+30 FILTER	+34 FILTER
C	+30	+30	+34
B	+2	NONE	+2
A	+12	NONE	+12
PIN	VOLT	VOLT	VOLTAGE
	VAR. 0 & 1	VAR. 2 & 3	VARIATIONS 4 & 5

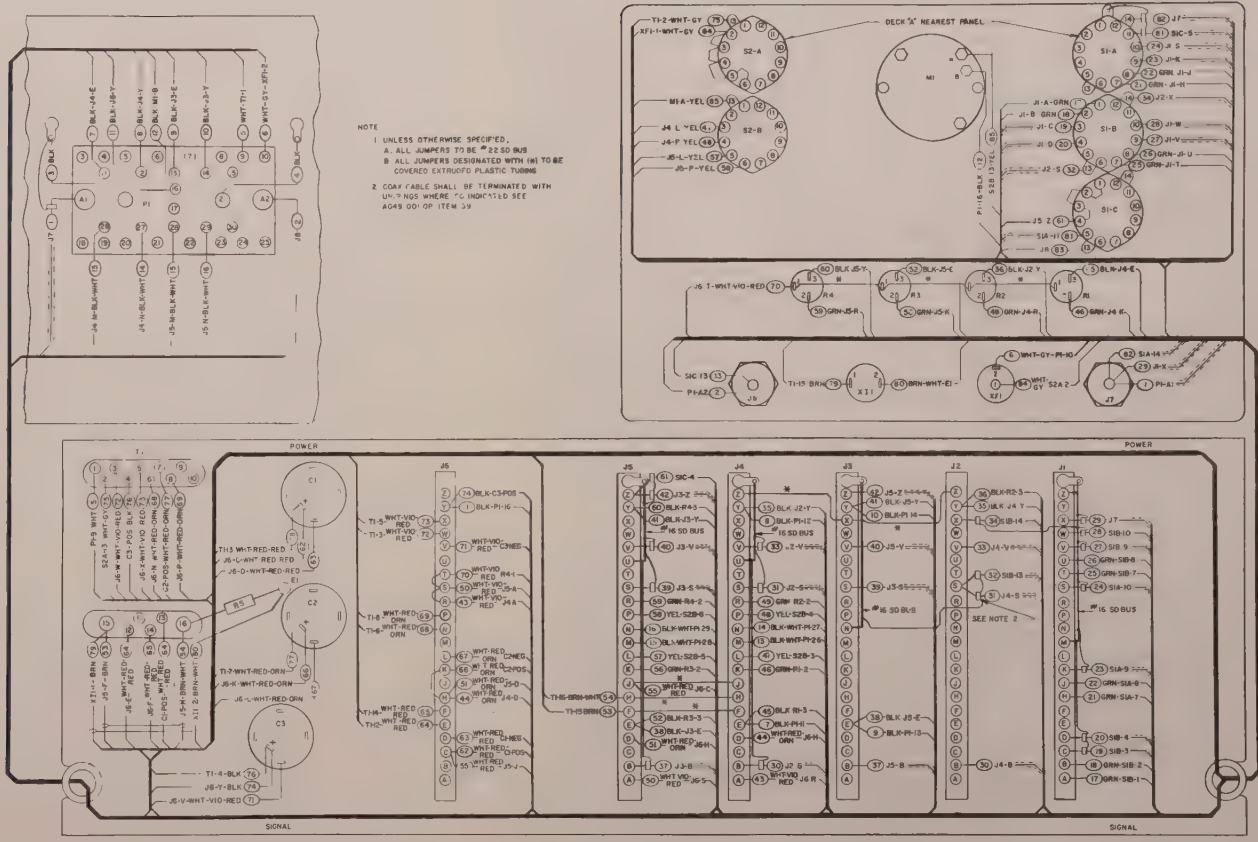
SUPPLY VOLTAGES VS DIFFERENT VARIATIONS

3

043 031 2S

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC DIAGRAM POWER SUPPLY REGULATOR	
SHT NO.	
SIZE	
REV. NO.	
PROJECT 1825	C043 031 0S
SHEET 2 OF SHEETS	


DUAL DC AMPLIFIER #1
6.334-2
DUAL DC AMPLIFIER #2
6.334-2
POWER SUPPLY REGULATOR
43.031-2
METER & PROT. NETWORK
49.030
BALANCE ADJUST
-15V
+30V OUT
-15V OUT
+15V OUT
6.3V
5A
OUTPUT
INPUT
RANGE
BALANCE
OFF
POWER
CABLE
19.149
AMPLIFIER NETWORK 12.207
AMPLIFIER NETWORK 12.209
RESISTOR NETWORK 12.223
NOTES
1 UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE ±05%
ALL DIODES ARE 1N459
ELECTRONIC ASSOCIATES, INC
LONG BRANCH, NEW JERSEY
SIMPLIFIED
SCHEMATIC DIAGRAM
AC-DC CONVERTER
1825 D049 001 05


NOTE
1 UNLESS OTHERWISE SPECIFIED,
A. ALL JUMPERS TO BE #22 SD BUS
B ALL JUMPERS DESIGNATED WITH (N) TO BE COVERED EXTRUDED PLASTIC TUBING
2 COAX CABLE SHALL BE TERMINATED WITH UNIONS WHERE INDICATED SEE A049 001 OP ITEM 59
DECK "A" NEAREST PANEL
POWER
SIGNAL
SEE NOTE 2

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

WIRING

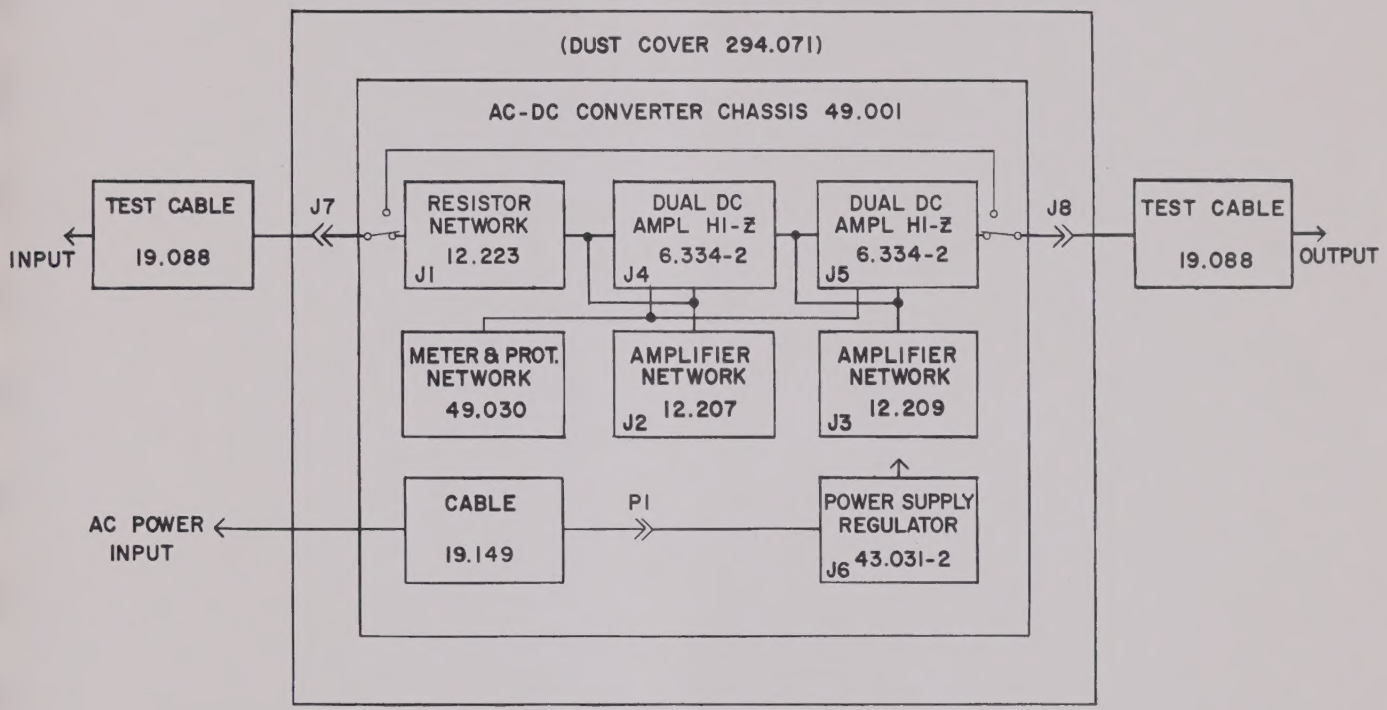
AC-DC CONVERTER

SHT NO	2	3
SIZE	A	4
DWG NO	A	2

PROJECT 1825 D049 001 0W

SHEET OF 3 SHEETS

PORTABLE AC-DC CONVERTER 49.019



ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
INFORMATION AC-DC CONVERTER (KEYSHEET)	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1825	B049 001 0H
SHEET	OF SHEETS